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HYPERBRACHYCEPHALY AS INFLUENCED BY CULTURAL CONDITIONING

BY

J. FRANKLIN EWING, S.J.

PUBLISHED WITH THE ASSISTANCE OF

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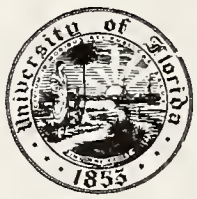

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TO MY MOTHER

ACKNOWLEDGMENTS

IN THE collection of data for and the composition of this small study, I have inevitably had to draw heavily on the kindness and counsel of many. Those I wish in particular to mention gratefully are: my Mother; a large number of hospitable members of the Maronite hierarchy and laity; my Jesuit Superiors; Professor Earnest A. Hooton of Harvard University; Professor John Otis Brew, Director of the Peabody Museum of Harvard University; Professor Joseph B. Birdsell of the University of California; Dr. Robert W. Ehrich of Brooklyn and Hunter Colleges; Miss Constance Ashenden and Miss Margaret Currier, former and present Librarians of Peabody Museum Library; Miss Florence McCourt, formerly of the Boston Medical Library; Miss Cordelia Galt and Mrs. Melville Smith, in charge of publications for the Peabody Museum; Mr. Frederick P. Orchard, Assistant Curator of Archæology in the same Museum. A grant-in-aid from the Viking Fund of New York which enabled this study to be published is also hereby acknowledged with gratitude.

J. FRANKLIN EWING, S.J.

Fordham University
New York
June, 1949

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

HYPERBRACHYCEPHALY AS INFLUENCED BY CULTURAL CONDITIONING

THE SUBJECTS OF THE EXPERIMENT

THE LEBANESE MARONITES

THE subjects for this experiment in comparative anthropometry are drawn from a group known as the *Maronites*. These are people adhering to a section of the Catholic Church known as an Oriental Rite; although united to Rome and completely a part of the Universal Church, an Oriental Rite is distinguished by the possession of a liturgy in a non-Latin tongue and by distinctive religious and canonical customs. That the Maronites are demarcated from other groups territorially adjacent to them not only by religious affiliation but by other factors with ethnic connotation will be shown in the course of this chapter.

THE HISTORY OF THE MARONITES

The Maronites (Leclerq, 1932; Labourt, 1910), although at present resident in the Lebanon, are originally from northwestern Syria. They derive their name ultimately from that of *Mar* (Saint) *Marūn*, who lived near Apamea (the present Qal'at el-Mudīq), in the fifth century A.D. (Timotheus, vol. 86, col. 65; Theodoretus, vol. 82, cols. 1418, 1431, 1491 ff.; St. John Chrysostom, vol. 52, col. 630). Apamea was the capital of the Roman administrative province of *Syria Salutaris*. The name of this Saint was given to a large monastery, located on the right bank of the Orontes River, between Apamea and Homs (Nau, 1902, II: 20–25). *Deir Beit Marūn*, or simply *Beit Marūn*, became a very large and important monastery (Ma'sūdi: 153; Burton, 1872: 64), and its representatives often had precedence in signing ecclesiastical documents (Mansi, VIII: 425–29, 1022). Gradually, a large number of the folk living in the neighborhood of the monastery (*Deir*) grew to be, and to become known as, adherents of the monks of the monastery, and the name *Maronites* was born. At first, it seems, the Maronites were grouped compactly around Apamea; later they are found farther along the Orontes Valley and elsewhere, e.g., at Ma'arrat-an-Noman, Hama, and Homs; and, still later, at Aleppo and other more distant cities (Denis of Tell Mahrē, III: 362–64).

In the course of time the Maronites became involved in the Christological debates that engaged the Near Eastern world. In the seventh century first the conquering Persians and then the Mohammedan Arabs added new difficulties to their lives, for both sided with the Jacobites, who were Monophysites (founded by Jacob Baraidos in the sixth century), and the antagonists of the Maronites. Such hardship imposed from without could hardly have had any other effect than a strengthening of Maronite group solidarity. It is certain that by the eighth century a religious group known as the Maronites was clearly to be distinguished from other such groups in Syria (Labourt, 1910: 687); that is a statement of the utmost conservatism. This group always seems to have been predominantly a people of the mountains and hill-country.

As a result of opposition and persecution, the Maronites gradually began to seek refuge in a more sheltered area. The slow movement toward the northern and highest section of the Lebanon mountains began very probably in the seventh century (Dib, 1924, col. 32–33), and was certainly essentially complete by the ninth century. The once-prosperous monastery, *Deir Marūn*, fell on hard times; it was in ruins between the end of the ninth and the middle of the tenth century (Leclerq, 1932, col. 2202). But its lapse did not connote the end of the Maronite Church. The renewed organization of that Church in the Lebanese mountains was signalized by the erection of a Patriarchate. The exact dating of this event is disputed; but it gave formal expression to a process already substantially completed, namely, the creation of a "rite-nation."

Greek was the doctrinal language of the monks of *Beit Marūn*, but in all probability the people spoke a western sub-species of Syriac (Burkitt, 1929). At the time of the Maronite withdrawal into the mountains of the Lebanon,

the official liturgical language of these people, as well as the popular language, was Syriac. Gradually, Arabic came to be adopted, the process beginning with the southernmost parts of their territory; it is only about two hundred and fifty years ago that Syriac was completely displaced as the popular tongue (Roque, 1723: 175). The liturgical language remains Syriac. The linguistic fact helps corroborate the Syrian origin of the Maronites.

During the struggles that marked the history of the seventh century A.D. in Syria, we hear for the first time of one of the two chief candidates for factors of racial complication in the early history of the Maronites as a separate group. The *Mardaites* (their name is strikingly similar to that of the Mardians of northern Iran [Lawrence, 1935] whose appellation also has no ethnic significance), or "Rebels," are confused in the records with the Maronites. They came from the Amanus mountains, and entered Syria as auxiliary troups of the Byzantine Emperor, towards the end of the seventh century. After complicated political and military events, the chief of the Mardaites was murdered at Homs; the unit was abandoned by the Empire. Parties of refugees from the Mardaites fled to the Lebanon mountains. There they no doubt mingled with those of the Maronites who had already arrived. I have no data on the number of these Mardaites who settled in the Lebanon; I cannot think it was large (Lammens, 1921, I: 81–83; Hitti, 1940: 204–05).

The second group capable of supplying an addition to the Maronite numbers was that of the people of the littoral plain, which the Maronites would have had to cross on their way to the mountain. I have no way of estimating how much intermarriage took place between the early Maronites and the plains people, who could hardly have been racially very different from the peoples of the Syrian Saddle.

A third, and very much smaller, element of possible mixture with the Maronites at the time of their entry into the Lebanon range could have been the various brigand bands, which found the caves of the limestone mountains ideal operational headquarters. This sort of activity was of respectable antiquity (Strabo, bk. 16, c. 2, sect. 18); but the numbers of such brigands could hardly have been great, and their ability to add any disturbing element to the racial blend was negligible.

In any case, the second two of the three groups just mentioned certainly (and the first probably) were of the Near Eastern brand of the Mediterranean race, characteristics of which are plentifully found in living Maronites. The people of the plains were of the same type as those of the desert-border of today.

The Maronites of the Lebanon, and elsewhere, were persecuted by various Mohammedan rulers, notably the Abbasids; this led to more than one revolt on their part (Lammens, 1921, I: 131–32). Such events, together with their new-found geographical concentration and isolation, must have further contributed to consciousness of group solidarity.

The Crusaders and the Maronites were on friendly relations from the start (Labourt, 1910: 685; Ristelhueber, 1925: 19–20). As a result of their alliance and of the continued support of the Crusaders, the Maronites were able to continue to consolidate their position in the north of the Lebanon (Lammens, 1921, I: 249). About the time of the final expulsion of the Crusaders (A.D. 1291), portions of the Lebanon range were invaded by two new groups. The first was that of the Metwalis, a Shi'ite Moslem group. The Metwalis came from the desert, and settled chiefly in the Beka'a, or what the Greeks had called Coele-Syria, namely, the valley between the Lebanon and Anti-Lebanon ranges (Lammens, 1929). The second group was that of the Druzes, who possess an eclectic and esoteric religion (Lammens, 1921, II: 13; Hitti, 1928; Hughes, 1885; Churchill, 1862). The Druzes settled chiefly on the southern and central slopes and ridges of the Lebanon range.

Seljuk, Mameluke, and Ottoman Turk rulers appeared in succession, the last holding sway from the sixteenth to the twentieth century. In the fifteenth, the Maronites, favored by a decimation of Moslem dissidents that occurred under the Mamelukes, overflowed into the Kesrūan, or south-central part of the Lebanon (Lammens, 1921: II, 16). From the sixteenth to the eighteenth century, they penetrated deeply into the Druze territory of the southern Lebanon (p. 93), assisted by internecine strife among Druze nobles. The two processes, penetration into Druze areas and symbiosis with

them (Laorty-Hadji, 1854: 77 ff.) continued; penetration, however, was slowed down after the beginning of the great emigrations of the Maronites to foreign lands. Symbiosis also existed between the Maronites and the various other religio-ethnic groups of the Lebanon (Rondot, 1947: 43 ff.).

Soon after the beginning of the nineteenth century, general restlessness in the area, further enhanced by foreign political intervention and the inept methods of the Ottoman Government, grew worse; in 1841, civil war broke out between the Maronites and the Druzes. The European Powers intervened, and two local governments were set up, a northern one for the Maronites, a southern for the Druzes. However, civil war soon broke out again. The disturbed political picture was further complicated by social and economic unrest. A climax came in 1860, when thousands of Christians were killed by the Druzes in the Lebanon (with the obvious connivance of the Turkish authorities) and other thousands by Moslems in Damascus. The Powers again intervened, and, by agreement, Emperor Napoleon III sent a military expedition to the district. An international commission set up a Sanjaq of Lebanon (whose boundaries were never definitely laid down), and established its autonomy (Hourani, 1946: 31–32).

After the first World War, the Lebanon (including much more territory than the old Sanjaq embraced) became a Republic under French Mandate; towards the end of the second World War, it rejected French tutelage, and it is now a completely autonomous state.

In spite of various vicissitudes, to which a minimum allusion has just been made, the Maronite nation had maintained its integrity almost completely (Thoumin, 1936: 26); its vassalage had only been demonstrated, for example in 1852, by the payment of a moderate amount of taxes (Laorty-Hadji, 1854: 81). This situation existed, evidently, because Turkish rulers were quite satisfied to leave immediate power in local hands (Hourani, 1946: 24, 27), so long as they received appropriate revenue and were caused no trouble; and because they recognized the principle of the "rite-nation," or the religio-ethnic group, according to which a person's status in political affairs was determined by his adherence to a religious or other appropriate group located in a definite territory (Rondot, 1947: 23 ff.), and the Turks preferred to govern through the rulers of a group.

Because of its Christianity, its union with Rome, its historical connections with France (Hourani, 1946: 146 ff.; Ristelhueber, 1925), and other reasons, the Maronite group has always been the one most influenced by European culture in the whole Near East (Thoumin, 1936: 6–7) — a fact which has helped to strengthen its reserve towards its neighbors.

RACIAL CONSIDERATIONS CONCERNING THE MARONITES

Race and History

The realization of the fact, thoroughly attested by history, that the Maronites attained and maintained the status of "national" or group solidarity, allows me to continue their study by considering more closely: first, the factors contributing to the possible racial homogeneity of the Maronites; and second, the actual racial situation of that group.

History informs us that the population, a portion of which entered into the formation of the Maronites, was resident in northern Syria, partly in the "Syrian Saddle" (Semple, 1931: 177, 182 ff.) (also neatly called the "Syrian Corridor" [Lyde, 1938: 291 ff.]), but mostly along the banks of the Orontes River.

This whole region forms a part of the "Fertile Crescent," and contains, in consequence, a section of the main route from the Persian Gulf to the Mediterranean. Antioch was the principal and richest city of the Saddle and, later, when the Maronites established their Patriarchate, the Patriarch was named "of Antioch and the East."

Syria was not only fertile; it was from very early times (Woolley, 1942; 1946) the home of the middleman par excellence (Bury, *et al.*, 1923: 297). Playing this rôle, it was famous. It was not until the opening of the Suez Canal that the area lost its trading pre-eminence. Even the climate and the geomorphology are complaisant (Semple, 1931: 184).

Syria was broken up, politically, into numerous small city-states until the period of its

domination by the Hittites (Lammens, 1921, I: 4), and has always been atomistic in tendency (Smith, 1935: 10). The map of the area dominated by the Hittites is interesting (Bury, *et al.*, 1923: map 5), because it shows their sway extended to Restan, a town certainly among those that furnished members for the Maronite nation-to-be.

ments of the future population. Babylonians, Egyptians, Hittites, Assyrians, Persians, Macedonians were prominent in military endeavor (Lammens, 1921, I: 8), and time after time the population of Arabia spilled over from the south into fertile Syria (Smith, 1935: 8). After 720 B.C., Mesopotamia and Egypt alternately dominated the Syrian states, until the Greeks

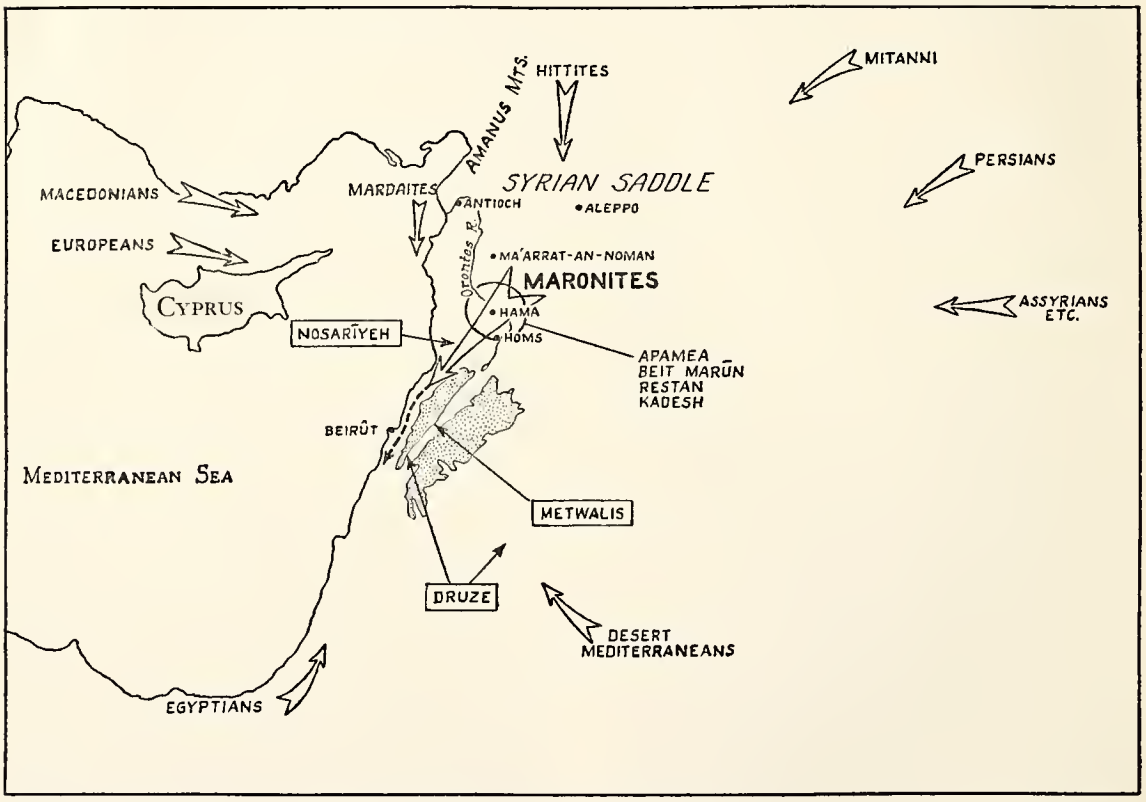


FIG. 1. General map of the eastern Mediterranean and countries bordering on it, showing locations and directions of movement of the various groups mentioned in the text.

Also within the area of the future Maronites was the city of Kadesh, the last remaining center of Hyksos power (Olmstead, 1939: 132); a city that commanded the road northward through inner Syria as well as the road from the interior to the Mediterranean through the Eleutherus Valley. Both roads were strategic for trade.

For reasons agricultural, mercantile, and political, the Syrian Saddle was much fought over, and that from time out of mind (Lammens, 1921, I: 15; Götze, 1936: 129). Back and forth went the tides of war — and human ele-

won the hegemony, to be followed, briefly, by the Armenians, and finally by the Romans. In the Christian era, Syria was ruled by Rome or Byzantium, with a short interlude for the Persians, from the conquest by Chosroes II in A.D. 616 until the Mohammedan invasion beginning in A.D. 638.

Shortly after this, we find mention in history of the only group whose presence in the Lebanon could seriously dispute the statement that the Maronites, on entering into their unpromising and rocky new land, found it empty of inhabitants. However, these Marda-

ites do not unduly complicate an already complicated racial picture. There could not have been too many of them, for the Arabic authors associate them with one particular village in the Amanus mountains; and their racial influence, even if they were of the utmost difference in type from the Maronites, would long since have been rendered that of a submerged minority.

By the ninth century A.D., the Maronites were safely installed in their bleak but sheltering mountain valley of the northern Lebanon. During the stay of the Crusaders in the Near East, there was some intermarrying of Maronites with the European bearers of the cross. These were probably for the most part French, Venetian, and other Mediterranean and Alpine folk, with a sprinkling of northern blonds (Lammens, 1921, I: 240). At the time of the Crusades, and for a century or two afterwards, the chief traders in this area from Europe were Venetians and Genoese (Rey, 1883; Heyd, 1923). Occasionally I heard mention, in the Lebanon, of a marriage with a French or an Italian Catholic in a Maronite colony, e.g., at Aleppo. Not only, however, were these marriages with Europeans largely confined to the upper classes, and small in number compared with the total Maronite marriages through the centuries, but the European contribution to the racial stock pot of the Maronites would be almost completely of elements, Mediterranean and Alpine, that were already represented there in large percentages. The same could be said, no doubt, for the Syrian Christians who joined their fortunes and their lives with those of the Maronites, from time to time (Volney, 1823: 468). Finally, the memory of family history is so long in the Lebanon, that the event of a European marrying into the family would still be remembered and mentioned hundreds of years afterwards.

This leads me to consider the factors that should be expected to produce racial homogeneity in the Maronite group, their history having given ample evidence of heterogeneity of origins and early experiences.

The most important factor, one of obvious and real importance in the Near East, is that of religious affiliation. I need submit no particular documentation when I say that religious lines are great barriers between peoples here, in terms of intermarriage. Even today, after the seeming relaxations of old customs consequent upon the first World War and subsequent vicissitudes, I am safe in saying that a Maronite would not often marry a Greek Catholic (who differs from him only in rite, since both groups are Catholic), much less a Moslem. Religious lines are indeed large elements in ethnic lines throughout the whole area (Lammens, 1921, I: 5; Kappers, 1934: 6; Rondot, 1947).

The marginal nature of the Lebanon terrain, and the intense group consciousness which centuries of comparative isolation and minority life have created, are other factors which are conducive to homogeneity. The closeness of the Maronite farmer to the land also slows down racial change, for the peasant is a conservative creature. It was almost exclusively this class that I studied while in the Lebanon. The average Lebanese Maronite man marries a woman of his own village. In making this statement, I refer to the mountain farmer. Of 179 men in my various series who had married, 92.7 per cent had taken a wife from the same village, while 4 others had wives from villages so close by as to be indistinguishable from the man's village. So, effectively, 94.9 per cent of the men studied had married locally. With but rare exceptions, this sort of thing has been going on among the Maronites since at least the ninth century. We have, therefore, a people drawn from a population of diverse origins. These origins contributed a limited number of racial complexes to the composite; these I shall list in the next section. This people then settled down to relative isolation and narrowly local endogamy.

The Present Racial Status of the Maronites

Speaking generally, the Maronites do not strike any discordant note in the anthropological chorus of the mountain-dwellers of the Near East (Seltzer, 1936; Kappers, 1934: 12–28; 193).

They are the most hyperbrachycephalic of any people in the neighborhood. Their cephalic index is 88.43, in the case of my adult male series; 254 (male and female) skulls yielded an index of 87. However, near-by Nosarīyeh, Metwalis, and Druzes come close to this very high index (Seltzer, 1936: 12; Shanklin, 1938; Chantre, 1881–82: 179).

Metrically, my series agrees fairly well with the small one of Huxley (Seltzer, 1940: 38), who measured 31 Maronite males. Huxley's subjects were not so planoccipital; he gets a longer head length and a narrower head breadth than I obtain; and his head height is so much greater than mine (almost 9 millimeters) that a difference in technique must be deduced. However, I shall discuss the metric details of the Maronite head and face in the next chapter. Maronite male stature is a shade over 167 centimeters in average.

My Maronites are not too different also from the Lebanese measured by Cline (Seltzer, 1936). I interpret his somewhat longer and narrower heads and faces as being due to a greater amount of Moslem Arab in his sample.

A preliminary sorting of my Maronite series by photographs clearly shows that there are the following predominant racial elements in the Maronite group (following the terminology of Hooton, 1946: 576–78): Upper Palæolithic, Iranian Plateau, Classic Mediterranean, Alpine. There is a fair amount of what Seltzer (1936) calls "Armenoid," in the sense of a light-brown-eyed, depressed-nasal-tip strain. In addition to the predominant elements, in terms of primary sub-races, there is a not inconsiderable amount of Nordic. And finally, there is just the faintest trace of Negroid.

Considered from the point of view of the various sigmas and coefficients of variation (Howells, 1936), the Maronites are not noticeably heterogeneous.

Since it would lead me too far afield at the moment to submit a more detailed account of the anthropology of the Maronites and a comparison of these people with their neighbors, I take the liberty of considering this brief account sufficient for the treatment of the racial characteristics and position of the Lebanese Maronite subjects of our experiment.

THE MILIEU OF THE MARONITES IN THE LEBANON

Geography (Keller, 1933)

The present boundaries of the Republic of the Lebanon (fig. 2) include much more territory than did those of the old Sanjaq of Mount Lebanon. The Sanjaq was composed of the Lebanon range, which was largely populated by Maronites, except for the southern section, the district of the *Shūf*, where the Druzes long held out. The Sanjaq was considerably larger than the original nuclear district of the Maronites, around the Qadīsha River in the north of the range.

The State of Greater Lebanon, which became the present Republic of the Lebanon, was set up by the French after World War I, under mandate from the League of Nations. One side is bounded by the Mediterranean. The land boundary line (which encloses some 10,000 square kilometers) starts at the Mediterranean, north of Tripoli, follows the Nahr el-Kebīr eastward for a while, then turns southwestward; thence it follows the crest of the Anti-Lebanon mountains; leaving this line, it runs irregularly southwest and west to Nakūra, once more on the Mediterranean, south of the mouth of the Litani River. This state includes not only more than the original focal area of the ancient Maronites, but a great deal more than the area of their greatest expansion. The broad valley of the Beka'a, the western slope of the Anti-Lebanon range, the whole area of the southern Lebanon, the coastal plains and cities — these are all accretions, with respect to the Maronites.

A number of different groups always lived in what I think of here as Maronite territory; their numbers are increased in the Republic of the Lebanon. The following list of the religio-ethnic groups that go to make up the populational mosaic of the Lebanon is compiled from Hourani (1947):

Maronites	327,846
Other Christians	
Greek Orthodox	109,883
Greek Catholic	64,280
Armenian Orthodox	59,749
Armenian Catholic	10,048
Syrian Catholic	4,984
Syrian Orthodox	3,753
Protestants	10,440
Latins	3,117
Chaldaeans	1,330
Mohammedans	
Sunnis	235,595
Shi'ites	209,338
Druzes	73,311
Jews	5,666
Various	6,261
Total	1,125,601

FIG. 2. Map of the Lebanon, showing principal towns and other features.

The Maronites are largely concentrated in the Lebanon mountains and along the coasts of the Mediterranean, between lines drawn eastward from Tripoli and Sidon, respectively. The other Christians, with the exception of the Greek Orthodox, are mostly confined to the cities. The Sunni Mohammedans are especially to be found in the very north of the present Lebanon, and in Tripoli and Beirût, although a fair number are resident in the southern Lebanon and in the Beka'a. The Shi'ites' greatest strength is in the Beka'a and in the southern Lebanon. The Druzes inhabit the mountains east and southeast of Beirût.

These various groups are not unified in origin. Thus, many of the Moslems are from the "desert-border population" (Kappers, 1934: 68); the Armenians are obviously not long resident in the Lebanon in such strong numbers. Hence it is that a series like that of Kappers (1934: 22), labeled "Lebanese," may well turn out to be far from homogeneous; the same may be said for other series.

The capital of the young state fashioned from an old land is Beirût, called "Berytus" in Roman times, when it was famous for its law school. As one comes to Beirût by ship, one sees it against the massive gray-white backdrop of the Lebanon range. The topmost mountains are generally mantled in snow, and when there is no snow, the white highest limestone helps confirm the etymology of the name of the range and the country, the "White" (note the Aramaic *laban*, "white"). The Arabic name is *Libnēn*. The Lebanon range is far higher than its counterpart, the Anti-Lebanon range. The highest peak, Qurnet es-Saouda, in the north, rises to some 10,000 feet; Jebel Sannīn, to the south of that peak and visible from Beirût, is 9200 feet tall. From there the altitude diminishes the farther south the range is followed.

Along the coast of what was once Phoenicia, one finds the "out-door museum" at Ras el-Kelb, on whose limestone promontory passing armies have carved or attached their inscriptions from the days of the Assyrians to our own time; Byblos (now called Gebeil), with magnificant excavations revealing local human history from the Neolithic to the present; hints of ancient worship, such as the "Well of Astarte" or the sacred carp of Sheikh Bedawi (named after St. Anthony of Padua, for there was a Franciscan Convent here during the Crusades), near Tripoli. At the head of the stupendous gorge of the Qadīsha River stands the pitiable clump of the Cedars, all that is left of the once prosperous forests of these trees. The wood of the fallen ones went to make ships of the Egyptian navy or mummy cases for the land of the Nile (Woolley, 1946: 182), or was enshrined in the Temple at Jerusalem (3 Kings, chaps. 5, 6, 7), or was scattered abroad to play more prosaic rôles. In the Beka'a, the remains of the formidable concentration of temples at Baalbek are justly famous. Ruins of Crusader fortresses and of towers dating from the times of the Mamelukes; hidden temples, like those of Afka (where Venus and Adonis were worshipped) and Qal'at el-Fakhra on its remote clifftop; caves and rock shelters and terraces strewn with prehistoric flint tools — these and a hundred other relics of man's past in the Lebanon vie for attention with the motley mosaic of present human populations, themselves the product of so much history.

It is only recently, as secular events go, that the Maronites have expanded beyond the region to which they first came, the upper gorge of the Qadīsha River. There they found spectacular scenery, but hard living. The great white ridge towers over bare slopes, with here and there a stretch suitable for terracing. The country had not been cultivated before, and every available bit of land was soon built up into terraces, primarily for wheat; stone houses were built, and numerous mountain nooks and tops were supplied with churches. It is symbolic and fitting, in view of later Maronite history, that the valleys of the Lebanon range occupied by the Maronites now and later open out towards the west (Thoumin, 1936: 3). At first, and for long, however, the geography of the northern Lebanon offered refuge to the Maronites; and this stern and bare land demanded characteristics which became theirs: sturdiness, laboriousness, cohesiveness.

Geology (Zumoffen, 1926; Dubertret, 1933a)

The Lebanon range runs parallel to the Mediterranean coast and also flanks the western edge of a continuation of that depression, which, followed along the Jordan Valley, the

Dead Sea, the Gulf of Aqaba, and thence across the Red Sea, leads one to the Great Rift Valley of Africa. The Lebanon and Anti-Lebanon ranges are twin horsts, with the fossa of the Beka'a between them. The Beka'a seems rather to be the result of differential movement along a single fault, than a mere continuation of the Great Rift Valley. The northern end of the latter comes to rest in the Beirût area; there a new fault begins.

Jurassic limestone forms the core of the Lebanon massif. It is often widely exposed, and where it is, karst topography is developed, with its weird erosion-carving and its hidden little valleys. The higher parts of the plateau block are capped by Middle Cretaceous limestone (which is in turn lower than the Eocene limestone), and where it appears the relief is gentler, although still dolomitic. The two limestone series are separated by a complex of sands and clays, among which is the Nubian sandstone. These sands and clays produce a more fertile soil. A less profitable deposit is the chalky marl, of late Secondary and early Tertiary age, which occurs especially in the southern Lebanon. It forms a crusty hardpan, which resists current agricultural methods. In the Sidon area, this crust is some 13 feet thick (Fish, 1944: 239). Elsewhere, there are local deposits from younger periods: pockets of sands and clays and gravels, and of sandstones and conglomerates. Recent alluvial soils are found along the coast, and the Beka'a is rich in alluvial loam.

The underlying geology is of the utmost importance to the Maronite population. It, together with the climate, produced the soil, and the soil is pre-eminently important in the life of a people primarily agricultural. An additional factor is, of course, man himself, who has ruined so much of the soil by intensive deforestation, and made so many of the barren hillsides habitable and cultivated by multitudinous terraces. The configurations of the rocks, acted upon by weather and fluviatile erosion, furnishes the Lebanon with those tiny, isolated and charming valleys, typical of karst country; with the moderate slopes of the more recent limestone; with the precipitous cliffs and sharp, deep gorges that helped to keep alien human influence at a minimum.

Once most of the trees had been cut down — a destruction that was already far advanced, but not yet consummated (Thoumin, 1936: 167), long before the Maronites arrived — there were no mineral resources to tempt the ambitious conqueror, who would unwittingly add new anthropological elements to the existing mixture. In the Lebanon there are the ruins of a few tiny iron mines, worked perhaps in the second millennium B.C.; the Lower Cretaceous rocks contain an occasional lens of lignite, not worth the effort of extraction (Fish, 1944: 240).

The geology of the country is kind to the Maronites in one important respect: it allows of numerous springs and a fair number of short but permanent rivers. The water, percolating through the more permeable limestone cap (Jurassic rocks are particularly permeable; the Cenomanian- Turonian and Middle Eocene, very permeable), reaches a resistant level (the Neocomian-Aptian-Albian and the Pliocene are especially impermeable) and bursts forth in a line of springs (Dubertret, 1933b: 450). "La percolation des massifs-réservoirs est accompagnée de frottements importants et est lente, circonstances à la faveur desquelles se constituent de vastes accumulations d'eau, dont témoigne *la constance des débits de nombreuses sources, en dehors de la saison pluvieuse*, soit dans le cours d'une même année, soit d'une année à l'autre" (p. 452). Because of topographical and social factors (Thoumin, 1936: 96–97), the Lebanon has no great system of irrigation. The farmers depend on the winter rains for the watering of their crops. But there is always fresh and sweet water to drink from the springs.

Climate

The orography of the Lebanon co-operates with the latitude and geographical position of the area to produce the climate. The general type experienced here is that called "Mediterranean" (Blair, 1942: 367; James, 1935: 95), characteristic of the western edges of continents in the fairly low latitudes. It is similar, for example, to the climate of parts of California. This type of climate is noted as possessing: (a) mild winters with light to moderate rainfall, (b) warm summers, with considerable periods of no rain, (c) abundant sunshine in both periods, (d) a natural vegetation consisting of broad-leaved evergreens and drought-resistant trees and shrubs, (e) a mean temperature, in

the coldest month, of above 43 degrees F., and more typically of one of about 50 degrees F.

The climate of the various parts of the Lebanon might be further distinguished, especially as regards maritime, mountain, and inland areas (Combier, 1933), but this general description will suffice, especially as no stations seem to have been set up for meteorological observations exactly in the northern Lebanon at high altitudes, and hence accurate data for that area are lacking.

The rainfall is notable here in the winter, since the barrier of the Lebanon range is a command to the wet western winds of winter, coming in from over the Mediterranean, to let down their load of rain (Semple, 1931: 89). In the summer, the high, cool lands of the northern Lebanon often experience a pleasant dew at nightfall, a factor that farmers, in other unirrigated Mediterranean lands, take into account (compare: Genesis, c. XXVII, v. 28; Odyssey, Book XIII, lines 244–45).

The natural flora of the Lebanon need not be discussed here, beyond the statement that its distribution is spotty, due again to deforestation, and its character typical of Mediterranean countries with similar geographical and topographical conditions (Boulomoy, 1930; Thoumin, 1936: 11–14; Semple, 1931: 262 ff.; Fish, 1944: 244).

THE CUSTOMS OF THE MARONITES IN THE LEBANON

In this section, such customs of the Lebanese Maronites as directly affect their physical and racial status will be emphasized. Brief remarks concerning other customs will only be made with the intent of rounding out the picture of the life of the people. The conditioning they receive in the Lebanon precisely as subjects for our anthropometrical experiment is our paramount interest at the moment. However, the Maronites are not so well known in anthropological literature, that information on their way of life is completely superfluous and irrelevant.

Housing (Thoumin, 1936: 292–95)

The Maronites of the mountain villages of the Lebanon live in stone houses, made of large, fairly well-tailored blocks of limestone. The walls are usually plastered inside with a marly clay or with plaster; the floor is of beaten earth or of stone slabs. The roofs of the houses are either flat (of beams, brush, and earth in the Near Eastern manner) or tiled and gabled (after the recently introduced foreign manner). The houses are simple, but quite adequate. There are very few indoor toilets, but folk who do not possess the American preoccupation with plumbing do not mind this. The houses are, for the most part, equipped with occidental chairs and tables, and squatting is not the usual custom in the house, although an occasional amount of it is done in the fields or elsewhere. There is no other method of heating the house in the winter than the charcoal brazier. In general, the Lebanese houses are superior to the dwellings of many other inhabitants of the Near East.

Villages

The organization of the villages, and the types of villages that one finds in the Lebanon (Tannous, 1944b; Thoumin, 1936: 283 ff.), are not of too much importance to this study. The terrace-villages drift gradually down the slopes of valley sides, which are broken by more or less definite terraces (e.g., Kartaba). The crest-village ("Strassendorf") consists of a row of houses on either side of a street which follows the crest of a mountain (e.g., Muzraat Kofr Debian). The hilltop-village (a type which may well include the plateau-village) takes advantage of the brow of a hill or the somewhat flat remains of a plateau near the gorge carved in it (e.g., Kforsghob, Bsharrē). In any case, getting about a village usually demands considerable muscular exertion on the part of the citizen.

The altitude of the villages varies from slightly above sea-level, for the coastal Maronites, through the low and sloping provinces such as Kesrūan, up the steep inclines of the Lebanon range to about 6000 feet. The majority of my Lebanese Maronite subjects live at moderate to considerable altitudes. It is impossible to say whether this fact has any bearing on measurements and observations. I doubt that there is any; no difference was observed between smaller series made up of lowland and highland Maronites, respectively.

A large number of the people who were measured in a village at a high altitude spend

their winters on the littoral plain. The phenomenon known as transhumance, which occurs elsewhere in similar geographical situations (James, 1935: 330; Brunhes, 1925, chap. 8; Thoumin, 1936: 155), and which denotes a shifting of the residence to lower or higher levels according to the season of cold or warmth, obtains here. In the Lebanon, some folk go so far as to have two villages: a summer village at high altitudes, and a winter village at low levels (e.g., Tannurīn el-Fawka and Tannurīn el-Takhta).

Communications

The present boundaries of the Lebanon enclose railroad lines, but no railroad complicates the life of the residents of the mountains themselves. Of recent times, the automobile and the asphalt road have penetrated the range. Various roads travel up the principal valleys and along the main ridges. Thus the age-old isolation of the Maronites has been broken. The effects of the automobile on the Lebanon have been many and important (Thoumin, 1936: 182 ff.), but most of the small farmers and laborers of the mountain Maronites have been little affected by this recent invention. The future effects are only a subject for speculation.

The Life Cycle

Marriage, Birth, Infancy

Marriage customs among the Lebanese Maronites have not changed essentially since 1914 (Chémali, 1915–16), except for the disappearance of the "horn" (*tantūra*) which decked the head of the bride. It is as true now as it was then that people marry young in the Lebanon (p. 913). There is, I think, much more of the element of personal choice in the selection of a spouse than there was of old, but, as I have already indicated, a man usually marries in his native village.

The Near Eastern preference for a male child as opposed to a female child might lead to greater care being taken during birth and infancy of the male child, but this is difficult to determine. There are numerous interesting customs associated with the birth of a child (Chémali, 1910) but I pass them over as non-essential, to discuss at length a custom practised during infancy which is of the most fundamental importance to our present study. That is the cradling of the child.

As will be seen from the photographs, the Maronite cradle, although simpler in decoration as a rule, is very close in form and function to that of the Armenians (photographs, Virchow, 1924) and to that of the peoples of the Caucasus (Pflug, 1923; pl. 5, no. 21).

It is made of wood (fig. 3, *a*), and is typically of the rocker type, although occasionally hanging cradles are encountered (Chémali, 1910: 738, and pl. opp.). The hanging type is rarer. Between the headboard and the footboard of the rocking cradle runs a rod of wood, longitudinally, above the place where the infant will be laid. This may well be presumed to strengthen the structure. It is also employed by the mother, who leans on the rod when suckling the infant (which remains tied in the cradle meanwhile); and from it hang religious medals for the infant's protection, rattles, and other toys, designed to distract the baby (fig. 3, *c*).

The floor of the cradle, it will be noted, has a hole bored through it. Above this hole is a corresponding one in the mattress; the bed linens that lie under the infant are likewise perforated. When the cradle is made up, a pottery conical-based receptacle is inserted in the opening. This receptacle has a rim which prevents it from falling through.

The newborn infant is carefully wrapped in swaddling-bands, fully extended, with his arms exactly at his sides. He is placed on his back in the cradle. A lead-off tube (what Pflug, 1923, calls "Urinableiter") is attached to the penis of a male infant; a similar, only slightly modified one is inserted between the labia of a female infant. These lead-off tubes resemble nothing so much as tobacco pipes and are sometimes bought as such in the bazaars by tourists. Excellent illustrations of them are given in Lortet (1884b: 36); and a description of the cradle, by the same author, is as valid today as in 1884 (Lortet, 1884a: 84–87). The infant thus lies, swaddled, on his back, with what would be the stem of the tobacco pipe protruding through the swaddling-bands and directed into the receptacle. The little mummy

is again wrapped, but this time the bands encircle the body of the cradle as well (fig. 3, *d*), so the infant is securely fastened to the cradle. The exact placing of these bands may differ with different families and localities.

In some cases the infant is placed in this cradle immediately after the activities subsequent on birth (Pflug, 1923: 220), but certainly he is so cradled within a very few days after his entry into the world (Chémali, 1910: 738; Ploss, 1884: 113). My observations on this point — as on cradling is general — concur with the data given in the literature.

Whatever the individual variations, one important point to note is that the infant is *always* placed in and fastened to the cradle lying on his back. The second note of moment is the fact that the baby is so immobilized the greater portion of the day and night, and for a great many months. As a rule, the baby is taken out of the cradle only once a day, when the linens are changed. He is even fed while secured to the cradle. This goes on for a minimum of nine months, and a usual maximum of a year.

An important factor, the consequence of which will be realized in Chapter III, is the position of the pillow. This position falls into two categories. In the first case, representing the minority I should judge, the pillow is simply left flat under the head (fig. 3, *c*). In the second case, the pillow is arranged under the neck so that the child's chin is raised (fig. 3, *b*). This, according to local lore, tends to produce a longer neck — an esthetically desirable trait. In this second case, the child's head rests on the pillow, not on a plane parallel to the median transverse section plane of the body and head, but at an angle, with the lambdoid region pressing more firmly than the iniac region on the pillow.

The period of suckling the infant may last long; according to Chémali (1910: 739) for one year, two years, or even more. I am inclined to think that this period is not so lengthy these days.

During early infancy there is no deliberate cranial deformation practised on the child — no apparatus, no massaging of the head with the adult's hands. Gentle massage of the limbs with oil is frequently employed.

There has always been a fair amount of schooling given the boys in the Lebanon, especially in Syriac, the liturgical language (Chémali, 1917–18), and after World War I numerous French and some American schools were set up (Tannous, 1944a). But the average boy of the average farmer begins early to participate in the laborious life of his father.

There are no multilations practised on the growing boy or adult man among the Lebanese Maronites. A possible exception to this statement is motivated by medical beliefs, and is not important to our study. At, or extremely near bregma, there often appears a depression (visible on bald heads and often noticeable on skulls) made by the point of a red hot iron firmly applied to the head. The operation is performed for the purpose of curing prolonged colds or other bothersome respiratory troubles. The same operation is done on sheep, for the same purpose, and in the same way. Perhaps this has some distant relationship to the "T sincipital" of Manouvrier (1895; 1903; Grön, 1910), observed on Neolithic skulls; and to what Bockenheimer (1922) describes on Guanche crania (other references in Dingwall, 1931: 75).

Nothing about Maronite clothing, either old-fashioned or occidentalized, seems to have any direct relation to the shape of the head. The fairly heavy felt conical cap, its base surrounded by a turban-like cloth, is not adopted until a boy is well grown. It is being gradually supplanted by the *tarbūsh* (fez) and western-style hats.

Subsistence

The Acquiring of Subsistence. The labor of acquiring subsistence is, for the majority of the Lebanese Maronites, agricultural. It is seasonal work, depending as it does on the rains; it is even more laborious and less profitable than the work of an American farmer, because the tools (Thoumin, 1936: 134–35; Wakim, 1933) are not modern, and the small area of the difficult plots on the terraces prevents any use of farm machinery.

The type of plow is that universal in the Near East and familiar to all from illustrations in books on Egypt. For digging by hand there is the three-man spade (one pushing it, the others pulling on a rope attached to the shaft), the ordinary spade, and the large hoe. Other tools are the ox-drawn harrow and the threshing sledge (Thoumin, 1936: 136). This is

pulled by oxen around the surface of the built-up threshing area, many of which stand like low towers among the mountains (compare Wetzstein, 1873).

The Maronites found bare peaks and only isolated tiny patches of good agricultural land when they came to the Lebanon, and, in the course of the centuries, they have covered every available slope with terraces. This terrace-building is still part of the farmer's work. In addition to the labor associated with the cultivation of fields and orchards (Thoumin, 1936: 137–39), there is the set of activities connected with the care of sheep and goats. There is intermittent stonework, on houses and walls. Gathering the heavier wood for family use is also a man's job. Little hunting or fishing is done by the Maronites now, as returns have diminished to a minimum.

Omitting consideration of the few who follow specialized callings, I may sum up the work-life of the average Maronite of the Lebanon mountains as one which is laborious and toughening, but not particularly more so than that of the average American farmer a generation ago.

Food, Drink, Stimulation. I shall here give a brief account of the variety of stuffs available to the Maronites for food and drink. The qualification need scarcely be added that this represents a general, over-all picture. Not all the materials here mentioned are at hand at all times or in the same quantities for all individuals. I have no more accurate data to present, but could wish for more.

Cereals. "The reward of cereal cultivation is greater than that of any other form of agriculture," says Forde (1937: 418), and cereals form the greater part of Lebanese agricultural products. Among these, wheat is pre-eminent. It is used in great quantities in the flat, whole-wheat bread characteristic of the area, and in combination (usually as cracked whole-wheat) with meat and vegetables in various dishes. The value of wheat as a food need not be emphasized.

Barley is grown a little; it is looked down upon, being considered primarily a food for animals. Maize is also grown somewhat; durra occurs, but rarely. Rice is imported in considerable quantities and is used in the various "stuffed" dishes so dear to the Maronites.

Vegetables. The list of vegetables appears imposing, but the qualification already given still holds. On the list are: tomatoes, onions, various salad greens, an increasing amount of potatoes, mint, garlic, eggplant, cucumber (a great favorite when in season), cabbage, peas, various beans, squash, carrots, and beets. The last five items are of relatively recent introduction, at least in any quantity. Vegetables, on the whole, are of greater importance in the daily lives of the Lebanese Maronites than is meat.

Milk Products. Milk, usually from goats but occasionally from cows, is fermented into *laban* (like yoghurt) and eaten in that form, or further elaborated into *labni*, a sort of tangy cream cheese. The use of butter is practically unknown here. The protein and mineral value of these milk products in the daily diet of the Maronites is obvious.

Meat. The chief sources of meat in the Lebanon are sheep and goats. The sheep are of the fat-tailed variety, the magnitude of whose caudal extremities was exaggerated by Herodotus (bk. III, sect. 113). In the mountain villages, the animals are slaughtered on a Sunday; meat for the meals of the whole week is unheard of (even apart from days appointed by the Church for abstinence from meat). A very small amount of the meat (especially tender portions of lamb and liver) is eaten raw, as part of the canapés. A much larger amount is eaten, still raw (pounded into a paste with softened cracked wheat), in a favorite dish, *kibbi-nēyeh*. The rest is fried, roasted in small pieces on spits, employed in stews, or mixed with rice and pine nuts in the "stuffed" dishes (cabbage leaves, young grape leaves, small squash, for example). Not so much chicken, and no pork is to be noted here. An occasional hapless hare is caught in the fields and eaten.

Fruits. Olives are a staple of the diet of the Lebanese Maronites, and supply them with oil. Figs and apricots are favorites. Dates are much rarer here than in Iraq. Melons in season are plentiful on the coast. Oranges are grown locally to an extent, but most, together with grapefruit, are imported from Palestine. Some bananas are grown in small patches along the coast. Various American and French fruit trees have been imported recently, and apples, plums, and pears add to the variety of Lebanese fruits.

Pistachio nuts and almonds are the commonest nuts eaten. Walnuts and peanuts are sporadically abundant. I never observed any use

of acorns for food, although it seems a widespread enough eastern custom in eastern Mediterranean lands (Gifford, 1936).

Sweets. Sweets do not figure very prominently in the average diet of the Maronite farmer, except on major feast days. The flaky, honey-drenched pastry is typical of the Near East. Very little sugar is grown locally. Fresh grapes are boiled down to make a grape honey, much like molasses; a similar molasses is made from the pods of the carob tree.

Condiments. There is nothing extraordinary about the list of condiments: salt, pepper, garlic, mint, vinegar, and some mustard. However, much larger amounts of mint and garlic are used, especially in salads, than is customary in the United States.

Beverages. The universal drink for "cocktail time" is *arrak*, a very strong, colorless grape brandy, flavored with liquorice. *Arrak* is drunk mixed with water, the addition of which turns it white. The native cooked wines are also drunk.

The very strong, very thick, very hot coffee, served in tiny cups, characteristic of the Near East, is also in favor here. Sugar is added to taste. This beverage has strong social connotations, being associated with the pattern of hospitality, the ceremony of business, and the smooth flow of social intercourse.

Narcotics. The only narcotic employed by the Lebanese Maronite (except alcohol) is tobacco. The old narghile, leisurely in preparation and enjoyment, is yielding to the quicker cigarette. A certain amount of chewing of tobacco occurs, and the older folk often use snuff.

DEMOGRAPHY AND EMIGRATION

Demography

The population of the Lebanon is concentrated (Thoumin, 1936: 280) in the following areas: around Tripoli, Batrūn, Gebeil, Beirût (a very large district, the Shūf, is thickly populated here), and Sidon — these areas are along the coast; in the mountains, there are areas of concentration around Sīr, Bsharrē, Kartaba, and Beskinta; this last area is continuous with the district of Kesrūan, which in turn merges into the Shūf. The actual ridge of the range is uninhabited, and the eastern slopes of the range, steeper and provided with much less rain, are not populated, with the exception of a few towns at the edge of the Beka'a valley. The rest of the country has less than twenty persons per square kilometer. This distribution is described, naturally, with focus on the Maronites.

The population of the whole Lebanon, according to the census of 1932, was 885,000, including some 61,000 aliens (Fish, 1944: 251; Dodd, 1940: pl. 1, opp. p. 16). The total population given by Hourani (1947: 63), as of December 31, 1944, is 1,126,601; but I am not sure whether this total includes people inscribed under the different confessional categories but not actually living in the Lebanon. At any rate, my own studies of the Lebanese Maronites were made at a time when the population was probably not much greater than that indicated by the older figures. The density of population is over a hundred per square kilometer (Tannous, 1944b), or at least around a hundred (93, according to Fish, 1944: 251). Bonné (1945: 141) offers the following figures for the Lebanon, as of 1935: total area, 9355 kilometers^2; cultivable area, 5604 kilomters^2; population, 865,693; density per kilometer^2 of cultivable land, 152.5. On the basis of these figures, the people of the Lebanon have about 1.6 acre of cultivable land per person. Sax (1945: 260–62) estimates that 2.5 acres of arable land are needed to provide a person with food, clothing, and other necessities. This estimate is based on a reasonable crop standard and a reasonable standard of living. The more productive countries of Europe are able to support about one person per acre of arable land, after allowing for food imports. In the United States, we have been using about three acres per person; if we reduced our dietary standards to those of prewar Europe, this would permit us to get along pretty well on 1.5 acres per person; were we to be satisfied with the standard of the Asiatics, 0.5 acre would suffice for our needs.

These figures throw some light, I believe, on the subsistence-level of the Lebanese Maronites. The Maronites may have rather a poor time of it, judged by the norms of the pampered American; but their standard of living is quite sufficient. However, there is not a large

margin for surplus population; and I suspect that some of the figures I have quoted are based on an overestimate of the quality of the arable land.

The Near East, in common with other Mediterranean countries and with much of southern Asia (Bonné, 1945: 8) has a birth rate several times higher than that of European countries of the temperate zone, except Russia. The birth rate for Syria and the Lebanon is 30–45 per thousand. It is that of an unindustrialized area, compared with the European rate (Davis, 1945: 3–5) — a fact that will not unduly surprise the reader. But the death rate is also much higher than, say, the United States (Tannous, 1944b: 524).

The percentage growth of population for Syria and the Lebanon together, from 1900 to 1938, has been 145.8 (Bonné, 1945: 10). This growth has occurred in spite of the great amount of emigration from the Lebanon, which I shall discuss in the next section. At least some of this growth has been adventitious. In 1939, for instance, there was a large influx of Armenians from the Sanjak of Alexandretta, when that area was handed over to Turkey.

A noticeable amount of urbanization has also taken place in the Near East. The figures for a city in the Lebanon (its capital, Beirût) are: population in 1814, 15,000; in 1880, 80,000; in 1937, 180,000.

Emigration

In spite of the fact that the Lebanon is better off, agriculturally, than many another section of the Near East, it has led in the amount of emigration of its people to other countries.

One factor in this process has been the fact that the Lebanon has always looked toward the West and been more in contact with it than any other Near Eastern country (Thoumin, 1936: 6–7). More specifically, the Maronites of the Lebanon were a Christian minority in a Mohammedan land, ruled by Mohammedan Turks. While they partially escaped the continuous action of the social disapproval of a majority, still they realized some of its force, particularly when they attempted to spread beyond their narrow territorial boundaries. The first few emigrants, too, with their tales of undreamed-of prosperity in a new and shining world beyond the sea, would stimulate the desire of many to pass over into that world. The failures, naturally, would be ignored, especially by young men. The relative poorness of the land, coupled with the attractions of a nonagricultural vocation in the New World, helped swell the tide of emigration. It would seem that the Lebanon had reached "saturation" (Huntington, 1945: 559), and would not support a larger population unless new techniques were to be applied. The new techniques were not forthcoming. In the mountain reaches of the Lebanon, indeed, it would be very difficult to introduce them. The poor denuded slopes have been, through the centuries, covered with terraces at tremendous cost in human labor. Lowdermilk (1944: 417) estimates that the cost in human labor of leveling terrace slopes of 50 to 75 per cent near Beit ed-Dîn (by no means so difficult an area as the northern Lebanon) at 1944 wage scales would be between 2000 and 4000 dollars an acre. And there is little room in the Lebanon for new terraces. Finally, historical events swelled the number of emigrants from the Lebanon. There were very ancient colonies of Maronites on Cyprus and in Aleppo. Cyprus, particularly, had been the first refuge of the Maronites under persecution. But the massacres of 1860 were followed by the first great historically documented emigration, that to Egypt. The insurrection of 1925–26 encouraged departures to foreign lands. About 1890 intensive emigration to lands other than Egypt began. The United States and Canada were especially favored. Today, the various countries of South America, outstandingly Argentina, Brazil, and Uruguay, are still receiving large numbers of Maronite emigrants.

One estimate makes the number of people who have left their Lebanese home equal one-sixth of the actual population (Dodd, 1940: 26); another puts at 120,000 the number of persons who left Syria and the Lebanon in the period between 1860 and 1900 alone. In the early years of the twentieth century, 15,000 a year emigrated. The world depression and new immigration laws have caused the tide to dwindle. So, in 1928, 14,228 emigrants are listed from Syria and the Lebanon; in 1933, only 2324 (Bernstein, 1936).

Maronite leaders in this country with whom I have discussed the matter estimate that more

Maronites are at present living on the continents of North and South America than remain in the Lebanon. That means perhaps half a million. Some guesses go as high as almost a million on both continents.

The "colonies" of Maronites in the various cities of the United States, from which our series of their children was drawn, vary greatly in numbers. A sober estimate of the number of Maronites in Brooklyn is 3000. Detroit may have as many as 14,000. The smaller towns, as one should expect, have smaller, and also usually much more geographically compact, colonies.

THE AMERICAN MARONITES

The sturdy people of "Near Eastern" racial character, who left a laborious land to try their fortunes in a new world, have settled there and raised families. It is from their children that I select the subjects of the second series in this experiment in comparative anthropometry, the series I shall refer to as that of the American Maronites.

The subjects of this series were born and raised in American cities and towns: Boston, Brooklyn, Detroit, Scranton, Wilkes-Barre. None of these places affords the altitude of many of the Lebanese towns from which their parents emigrated. Being northern towns, however, their winters yield nothing in rigors to the Lebanese season. The outstanding difference between the milieu of these American Maronites and that of their parents, before emigration, lies in the fact that in the United States the habitat is cities or large towns; in the Lebanon, it was villages or small towns, founded solidly on an obviously agricultural basis.

In general, the subjects of the American Maronite series were from the ranks of the "middle class." Practically to a man, they work for their living as mechanics, office-workers, grocery-clerks, and the like. Their parents are, on the whole, moderately well off. But many of them did not enjoy this happy state at the time that our American subjects were born and received their early nurture.

During the early years of this century, the general standard of living of the average immigrant was not enviable. In some cases, crowding and its concomitant ills in the slums of our large American cities reached incredible proportions. So Wittke (1945: 439) writes: "Twenty-five years ago, there were sections of New York City, in the Sicilian district, where 1,231 people lived in 120 rooms, and only Greeks and Syrians surpassed the Italians in the use of all rooms for sleeping purposes." The varying picture of the vicissitudes of the Syrians (a term which then included Lebanese) in America may be read in Boughton (1911) and Hitti (1924). There is, naturally, great diversity in the fortunes and occupations of the various Maronite immigrants. It is notable, however, that very many of them took up the trade of providing food for other people, as restaurateurs and grocery-men; and other large numbers became merchants, starting as peddlers, and soon working up the ladder. One factor which seems to afford a reasonable, if partial, explanation of this double fact, is that the immigrants were for the larger part men of little formal education and were at the same time independent and hard-working. A small grocery store offers an ideal situation for such men; so does a merchant career, with its inception at the peddling level.

At present, with increasing prosperity, the Maronites are in the process — rather, the process is practically completed — of moving away from the old nuclear area of the "colony" and scattering throughout the city they inhabit.

However, the coherence of the group is still marked. I believe most of the American Maronites still marry Maronite girls; but the number of marriages with non-Maronites is on the increase. This is to be expected. The American Maronites are thoroughly assimilated; few of them know Arabic well, especially to speak it.

On the whole, the customs of the households to which the American Maronites belong before they are married, are almost as American as are the customs of their homes after marriage — and these latter are completely American.

They retain some of the old Lebanese foods (and they are worth retaining, to my taste), which are interspersed throughout a typically American menu. The *khobez mar'ū*, or tough and tasty mountain whole-wheat bread, is hardly seen on a Maronite table, in America; *arrak* has been supplanted by American drinks. But many of the old dishes linger on.

From the point of view of this study, the most interesting change in custom is that of the method of cradling the infant. The Lebanese Maronite custom, described at length in the preceding part of this chapter, has not only disappeared, but, so far as I can learn by questioning mothers, it disappeared from the start — exceptions to this are extremely rare.

The Maronites coming to this country from the Lebanon did not bring these cradles with them, and they had none made here. However, even though they laid their babies in an American-style crib or a bed, they still swaddled the baby to a certain extent. The mothers wrapped their infants in cloths, and laid the young ones on whatever form of bed they used.

As the comparison of cradled and uncradled heads is the particular point of this study, I naturally made extensive inquiries on this point. I feel sure that — for some reason I cannot fathom — most of the mothers of the subjects of my American Maronite series wrapped their sons more or less tightly in cloths for *two to three months*, and not for a longer period. Even when the mothers were most anxious to adopt the American way in everything and had the advice of nurses, and the like, they still adhered to this custom. The reason given: to insure straight limbs to the boy. Interestingly enough, many second-generation mothers are doing the same thing today.

The reason why I am still inclined to treat subjects thus handled during infancy as subjects with uncradled heads will develop as my study proceeds.

With regard to the rest of the customs of the American Maronites, and their milieu, little more need be said; the reader is presumed to understand that milieu thoroughly.

THE EXPERIMENT

THE PROBLEM

THE Lebanese Maronites are hyperbrachycephalic. In fact, their index, 88, surpasses that of any of their Syrian neighbors; it is itself surpassed by that of very few other peoples in the whole world (Martin, 1928: 778). In addition to this metrically expressed characteristic, they possess marked planoccipitaly. Planoccipitaly has long been considered as being by and large a racial characteristic (although with pronounced reservations on the part of some anthropologists, e.g., Hooton, 1946: 602).

If one were to consider the possibility that these characteristics of the Maronites had been caused by some mechanical and external factor inducing a variety of cranial deformation and were to cast about for the most likely candidate for a factor in this case, the method of cradling the infant employed by the Lebanese Maronites would immediately be given first consideration.

As will be seen from the review of the literature in Chapter IV, a variety of opinions is recorded on this very subject, that is, with regard to the effect of cradling on the head form. Many of these opinions are to the effect that cradling does produce, in whole or part, planoccipital hyperbrachycephaly among many peoples. It is to be hoped, therefore, that a comparative approach to the problem, using the Maronites as subjects, may yield the basis for a valuable generalization.

The comparative, or experimental, approach to the problem demands two series, identical in other respects, differing completely in method of infant postnatal treatment. We have two such series, one of Maronites born and reared in the Lebanon, where the custom of rigorous cradling obtains, and the other of Maronites born and reared in the United States, where the custom of cradling has fallen into desuetude from the first. We oppose, therefore, a cradled and a noncradled series, concentrating on the variable in question.

It is necessary to produce evidence that I have removed all except one major variable in this experiment. The description of the two series, of the methods employed in studying them, of the results of this study, and of the inevitable minor variables is the task of this chapter.

THE MATERIAL

Numbers and Sex

A total of 209 Lebanese Maronites were the subjects of the Lebanese series used in our comparison. The American Maronite series numbers 180.

All the subjects of both series were males, in a normal state of health.

Age

The subjects of both series range in age from those who have completed their eighteenth year to those at the beginning of their fiftieth year. The inclusion of subjects younger than twenty-one was motivated by several considerations. It was found that more young men were available for study in the United States than older men; then, too, one should not anticipate any essential change in head form after eighteen. In the end, the average age of the Lebanese series is 30.10 years; that of the American series, 26.28.

I feel that a slightly lower age for the American series might even be an advantage, inasmuch as it might tend to cancel out the possible increment in head length that would be correlated with the probably greater stature of the American Maronites (a probability I shall discuss shortly).

A comparison of the head measurements and indices of the various age-groups among the Lebanese Maronites (I measured a great many under twenty-one and even more over fifty, when in the field), is presented in table I. This comparison indicates that, so far as the Lebanese series is concerned, a comparison might just as validly be made with one age-group as with another. The slight and inevitable changes in the 45–x group do not enter into the discussion here.

TABLE I: COMPARISON OF AGE-GROUPS,
LEBANESE MARONITES

	Adults (21–50)	x–25	26–44	45–x
Head Length				
M	176.48 ±.325	177.19 ±.154	176.43 ±.133	175.29 ±.161
σ	6.51	6.99	6.42	6.30
V	3.69	3.95	3.64	3.59
Head Breadth				
M	156.25 ±278	155.89 ±.112	156.52 ±.115	154.90 ±.119
σ	5.58	5.10	5.56	4.66
V	3.57	3.27	3.55	3.01
Head Height				
M	130.84 ±.217	131.63 ±.985	130.54 ±.109	132.93 ±.140
σ	4.32	4.44	5.18	5.49
V	3.3	3.37	3.97	4.13
Head Circumference				
M	546.99 ±.755	549.19 ±.336	546.67 ±.302	541.55 ±.388
σ	15.2	15.27	14.58	15.2
V	2.78	2.78	2.67	2.8
Minimum Frontal				
M	105.54 ±.205	105.35 ±.271	105.48 ±.087	107.02 ±.105
σ	4.12	4.23	4.18	4.10
V	3.94	1.17	3.97	3.83
Cephalic Index				
M	88.43 ±.219	88.13 ±.924	88.44 ±.086	88.84 ±.109
σ	4.35	4.19	4.14	4.25
V	4.92	4.75	4.68	4.79
Head Height-Length				
M	74.26 ±.233	74.39 ±.794	73.16 ±.073	75.67 ±.107
σ	4.63	3.58	3.51	4.17
V	6.23	4.81	4.80	5.51
Head Height-Breadth				
M	83.89 ±.189	84.63 ±.072	83.64 ±.083	85.44 ±.823
σ	3.77	3.23	3.98	3.23
V	4.50	3.82	4.76	3.78
Zygo-Frontal				
M	75.39 ±.148	75.17 ±.406	75.35 ±.065	75.16 ±.078
σ	2.98	1.84	3.16	3.06
V	3.95	2.41	4.20	4.07
Average Age	31.66	20.3	33.1	58.4
N	180–184	94	106	70

Sampling

The primary area from which the subjects of the Lebanese Maronite series was drawn is very small; exactly the same remark may be applied to the American Maronite series, because the parents of these subjects came from the same area. The subjects of the Lebanese series, or the fathers and mothers of the American Maronite subjects, came from villages scattered throughout the Maronite land: especially from the original homeland of the Maronites, the territory of the Wadi Qadīsha, with a fair number from the Kesrūan District. Those few who were born outside of the Lebanon were carefully interrogated about their family history, which, as I have remarked,

they knew. The total number of towns from which the Lebanese subjects came was forty-one; for the American series, the total is fifty-six. The distribution of these towns is casual, and the same cultural and "national" area is covered in both series. These are minor considerations which I shall not present at length here. For instance, the custom of transhumance, mentioned in Chapter I, makes it difficult to be sure whether people come from one or the other of two towns, since their parents spent the winter in the first and their summer in the second.

We have here, then, a comparison of two general groups, drawn from the same cultural and "national" larger group.

THE TECHNIQUE

Selection of Subjects

In addition to the principle of sampling described, i.e., the cultural and "national" one, and in addition to the usual criteria applied to subjects of an anthropological study, such as age, normal good health, the final and critical norm of selection of subjects for the American Maronite series was that of the method of infant bedding which they experienced.

In determining the method of cradling, I showed the subjects photographs of the Lebanese method in action (fig. 3), and asked whether their younger brothers and sisters had been so treated, or whether there was such an object as the cradle in the attics of their homes. Elder brothers, when present, were asked about their younger brothers, who were being studied.

But the most effective information, as one should anticipate, came from the mothers of the subjects, who were questioned about the cradling of their sons, whenever possible. Almost as effective was the information elicited from the female neighbors. Particularly in the early days of intensive immigration into the United States by the Maronites and during the time when the subjects of the American series were being born and raised, the Maronites lived in compact enclaves in the locality. Nothing was secret from the neighbors, and, of course, there were always aunts, even more knowledgeable than neighbors.

With regard to the subjects studied in the American Maronite series, I can rule out the Lebanese cradling custom with certitude.

There remained, however, the variant mentioned in the first chapter, i.e., swaddling of short duration. The infant is swaddled and laid in the crib, thus wrapped for the first two or three months of its life. All the informants were clear on the point of time; this practice never is employed longer than the first three months. I am of the opinion that little or no deviating effect could be expected to manifest itself as a result of this custom, since it renders the infant immobile precisely at a period of its life when it would be helpless and usually reclining on its back, even if not so constrained.

Technique of Observations and Measurements

Observations

In studying the Lebanese series, I made use of the Harvard Anthropometry blanks (Hooton, 1946: 750–51). The observations pertinent to the problem we are studying here were: (a) Occipital Flattening, Abs., +, ++; (b) Occipital Protrusion, Abs., Sm., +, ++; (c) Lambdoidal Flattening, Abs., Sm., +, ++; (d) Cranial Asymmetry, Abs., Left, Right. At the time these observations were made, no special attention was being paid to the problem of occipital flattening, otherwise a more detailed scale should have been devised and used.

Before studying the living Lebanese Maronites, I investigated some 254 skulls of both sexes, from Maronite cemeteries of the Lebanon. The records of this study were lost during the war. But it is remembered that in the study of the skulls, a distinction was perceived and recorded between occipital flattening of a "hinged" or "slanting" nature, which was, as it were, hinged on the iniac region and the lowest part of the occipital bone above the iniac ridge and slanted forward to the obelionic region, and a "straight" flattening, which projects upward from the iniac ridge, in a plane perpendicular to the Frankfurt and the median

sagittal planes. This distinction will receive attention in a few pages.

In studying the American Maronite series, I found it useful to estimate and locate flattening by palpation. The hand is first placed on the head so that the thumb encounters one tuber parietale, the fingers the other. This operation always gives one an initial suspicion of flattening or normality, after acquisition of experience of the specific group involved. The other hand is placed against the back of the head (or the same hand is slid downwards) and is moved from the obelionic region to the nuchal musculature. Any peculiarities discovered are further investigated with the finger tips. Therefore, I should add the hand to the statement of the craniologist, His (1864: 10), that "das Auge der sicherste Führer ist und . . . der Massstab erst als kontrollierendes Hilfsmittel nachfolgen kann."

The only other observations made on the American Maronite series, beyond remarks on anything out of the ordinary, were those on eye color (taken without a scale), and hair color, taken (as in the case of the Lebanese series) with a Fischer-Saller scale.

Measurements

The usual instruments were employed in taking the measurements. The spreading and sliding calipers were the same models in both instances and were standard type. The head height, unfortunately, was measured according to two techniques. For the Lebanese series, Hrdlička's method with two calipers (Hrdlička, 1947: 89–92) was followed, but the calipers were held up fairly firmly and the height in a plane perpendicular to the Frankfort plane was taken, instead of the height at bregma. For the American series, Todd's Head Spanner, also firmly held up, was used.

Even though approximately seven years had intervened between the study of the Lebanese and that of the American series, every attempt was made to maintain a similar technique. Since the Lebanese series was measured immediately following on a study of the Maronite skulls, I was particularly conscious of a desire to approximate the skull measurements when measuring the living, consequently my technique was more than ordinarily heavy-handed. This same heavy-handedness was employed on the American Maronites. As much pressure was applied as the subject could bear, without pain. This was particularly the case in taking the bigonial diameter; the attempt to get as close as possible to the bone was vigorous. Consequently, all my measurements are probably somewhat smaller than those which another operator might obtain. However, every conscious effort was made to keep the personal factor steady for the two series.

I shall now discuss the individual measurements.

Head Length. This was the maximum length, glabella to opisthocranion, in the median sagittal plane (Howells, 1937: 492; Hooton, 1946: 757–58). In the case of the most severely flattened of the Lebanese heads, this measurement sometimes became largely a matter of judgment, since the length was pretty much the same over a large area of the posterior part of the head. As a matter of fact, often the lambdoid region or above it would have offered a greater length. However, I was prepared for this phenomenon by the study of the skulls and restricted the area of application of one point of the calipers to the occipital.

Head Breadth. The maximum breadth of the head, above the level of the ears (Hooton, 1946: 758).

Fortunately for this study, these two measurements are the essential ones, and at the same time they offer the possibility of suffering the least variation.

Head Height. The two methods employed, that of Hrdlička and that of Todd, have been compared by Todd (1925) on cadavers, and by Gray and Jacomb (1928) and Goldstein (1938) on the living (schoolboys). On the whole, the two methods yield not widely differing results. As Howells (1938: 193) says, "In each case the standard deviations yielded by Hrdlička's method were somewhat larger, though only Todd considered the difference to be of any significance." I am not as satisfied as Howells seems to be with the situation; still, I doubt that the results are noncomparable to an extent that renders a reporting on my findings in the two series completely useless. I made every effort, in using Hrdlička's method, to exert a firm, gentle pressure upwards on the calipers, and especially to keep them in a plane perpendicular to the Frankfurt plane.

Head Circumference. The horizontal head circumference, commencing at the glabella and going around the head as nearly as possible in a plane parallel to the Frankfurt plane.

Minimum Frontal. This measurement was taken at the customary points, with the same strong pressure characteristic of the other measurements.

Bizygomatic. The same remark applies to this measurement.

Bigonial. As mentioned before, special effort was made during the taking of this measurement in order to approximate the skeletal gonia.

Total Face Height. The height of the face, from nasion to menton, with moderate pressure being exercised on the menton region. The nasion was located by a combination of palpation and the method of Ashley-Montagu (1935), and lightly marked with a thumbnail.

Upper Face Height. Following the technique employed in the original Lebanese work, this measurement was also registered on the American series from nasion to a point approximating the bony prosthion, rather than the fleshy one.

In all this, it will be seen that I followed Martin (1928: 180 ff.) closely.

THE RESULTS. THE DATA OBTAINED FROM THE EXPERIMENT

The Observational Results

The occipital flattening among the Lebanese Maronites, as I have already noted, was of two types: a "hinged" type, and a "straight" type. These types are not, of course, mutually exclusive, nor does my isolation of these types indicate that I ignore the complete series of transitional flattenings that occur. However, the attention given to these two end-types will have its fruits, I hope, in a better understanding of the relations of flattening to the metrical data, and of the relations of lambdoidal to occipital flattening.

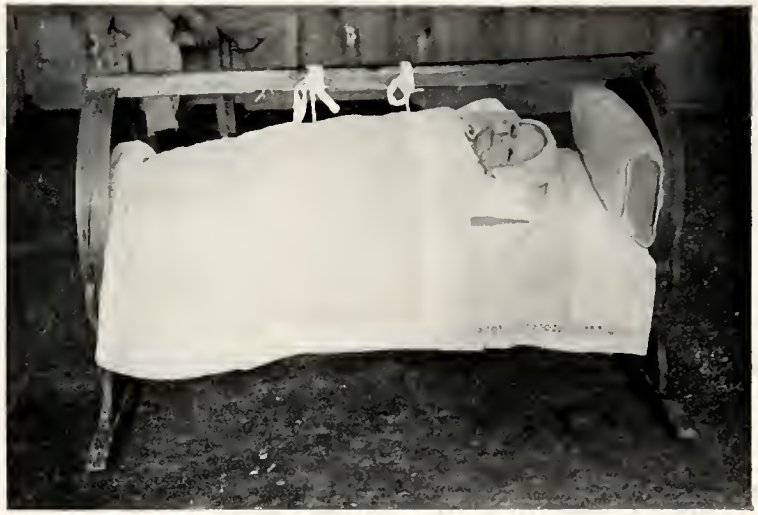
The "hinged" flattening, viewed in norma lateralis, is illustrated in the photographs of the skulls from Alkali Ridge (fig. 4, *a*, *b*). Through the kindness of Dr. J. O. Brew, and the Peabody Museum, Harvard University, I am allowed to use these photographs, which have already appeared in the publication on Alkali Ridge (Brew, 1946). A sketch of a Maronite skull, used as an example of a deformed skull, is given in his *Éléments* by Topinard (1885: 745); and several skulls so deformed are illustrated in Hooton (1930) and Newmann (1941: fig. 3). This "hinged" flattening is pretty much what Stewart (1940) calls lambdoidal deformation, and he, too, illustrates Indian skulls from the Whitewater District, eastern Arizona.

The point of this "hinged" flattening is that, when high, restricted to the lambdoidal region alone, and small, it may easily be passed over as merely a lambdoidal flattening. No observations, for instance, were made by Hrdlička (1908) on such flattening among Indians of the Southwest. Yet this deformation can, and does in many cases I have observed, also affect the measurements of the skull, specifically the breadth. I can well conceive of its also affecting the length, even to increasing this diameter. But not only is the breadth generally found to be the more variable character (Martin, 1928: 767), but the excessive projection of the tubera parietalia is quite observable on many skulls suffering from nothing more than a good, strong lambdoidal flattening. I am by no means saying that all lambdoidal flattening is a deformation, since I am in no position to make that statement at this juncture. But *some* lambdoidal flattenings are deformations, and some are large. It is interesting, in this connection, to compare the photographs of the Alkali Ridge Indians with the first of my photographs of Lebanese Maronites (fig. 4, *c*, *d*). Later I shall indicate how these deformations were created.

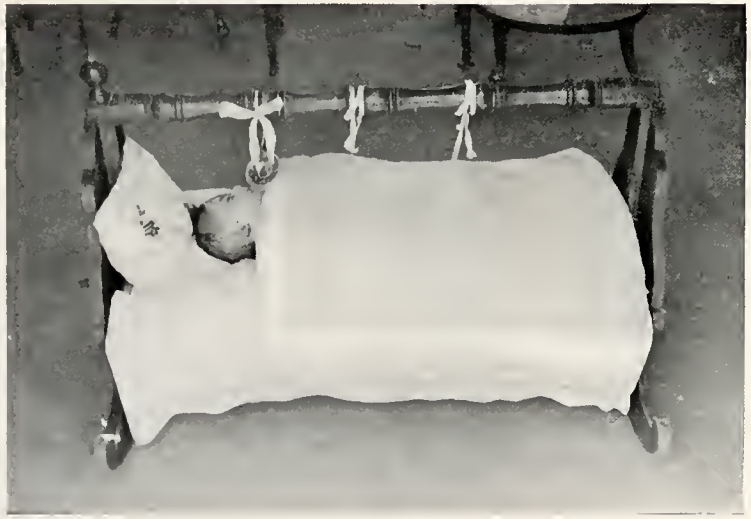
It is of some importance to the head length whether this "hinged" flattening invades the occipital bone area, or stays mostly above it, in the lambdoidal area. It can, on occasions, descend far, and still leave a small, but sharply protruding curve of the occipital bone between it and the torus.

It is rare that one finds a "straight" flattening, absolutely and mathematically fulfilling the requirement of forming a plane parallel to

a



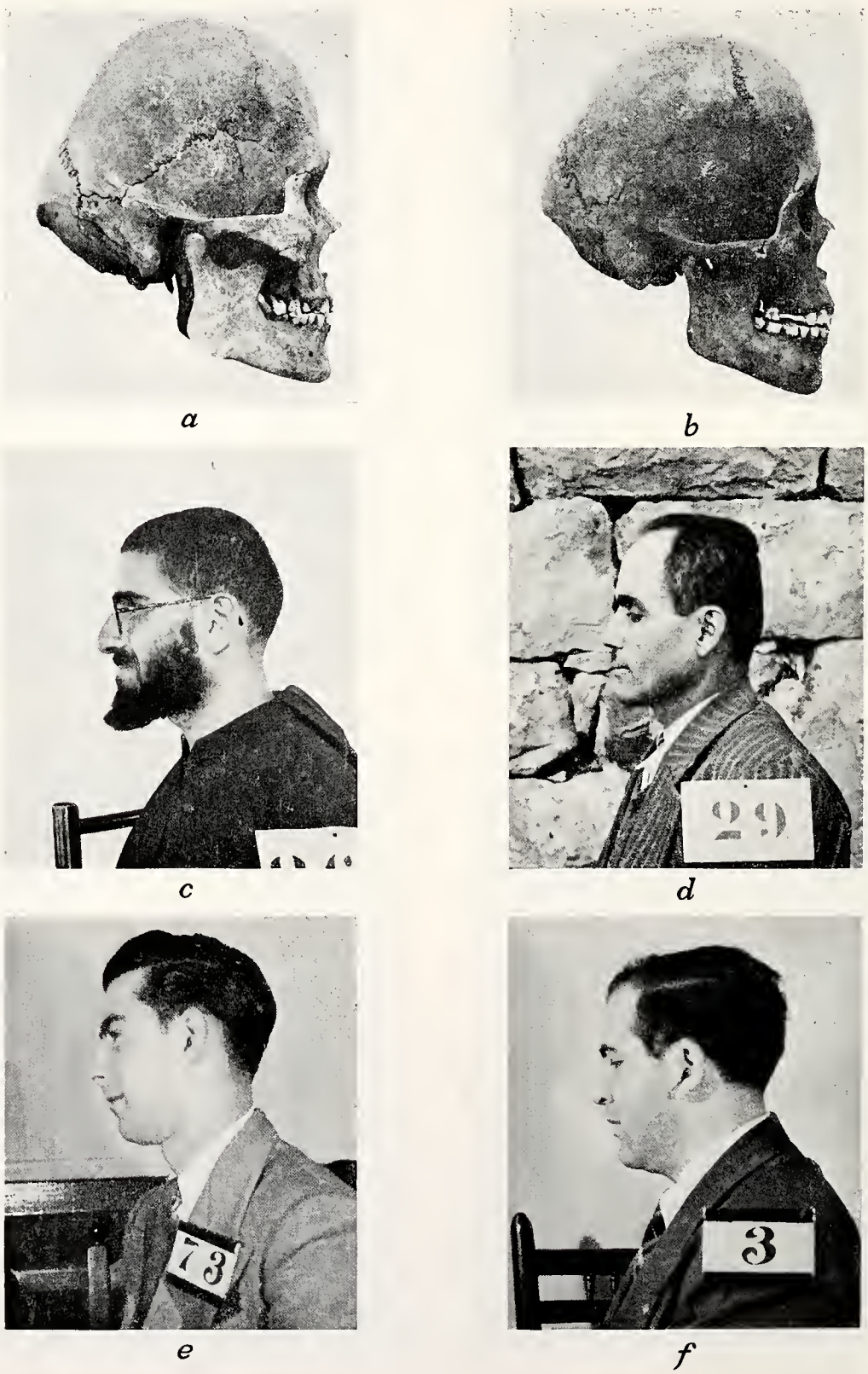
b



c

d

a, A typical cradle. *b–d*, Three Lebanese Maronite infants, cradled.



a, *b*, Alkali Ridge skulls, showing deformation — "hinged" flattening. *c*, *d*, Two Lebanese Maronite subjects, showing "hinged" and "straight" flattening, respectively. (Cephalic index of both, 88.) *e*, *f*, Two American Maronite subjects. (Cephalic index of both, 79.)

the median transverse plane, and perpendicular to the Frankfurt plane. However, from the point of view of the effect made on the metrical data, how much the flattening invades and presses in, the occipital bone is important. A contrast between the two types is presented in the first and second of the two photographs of the Lebanese Maronites (compare Newmann, 1941: figs. 3 and 4). These photographs were selected because both subjects had a cephalic index exactly the average for the Lebanese series, but showed different types of flattening.

The Lebanese Maronites as a series had occipital flattening to the following degrees: Absent, 2.17 per cent; +, 29.89 per cent; ++, 67.93 per cent. Lambdoidal flattening was: Absent, 95.11 per cent; Small, 3.26 per cent; +, 1.63 per cent. If I were reviewing these heads, I should make a different record today, especially with respect to categories. My impression is that the majority of the flattenings labeled "Occipital" invaded the occipital region seriously; and this impression is corroborated by the observation of the Lebanese Maronites encountered while I was studying the American Maronites. This invasion of the occipital region is also borne out by the metrical data, and the cephalic index, 88 for the living and 87 for the skulls of the Lebanese Maronites. However, I may well presume that the cephalic index would have been even higher, had all the flattening been of the "straight" variety. That lambdoidal deformation, or high "hinged" flattening, affects the cephalic index, is clear from the work of Hooton (1930) and, lately, that of Seltzer (1944) and Stewart (1940), all on ancient Indian skulls, and Hrdlička (1908) on living Indians.

The heads of my American Maronite series appeared very different, both to immediate and casual observation, and in tabulated observation, from those of their immediate ancestors. These heads showed 61.3 per cent of lambdoidal flattening. All of this flattening was small and well localized around lambda, except for 2.5 per cent which invaded the uppermost border of the occipital region. These latter were all found on the heads that had the highest cephalic indices of the series. Only one real case of almost "straight" occipital flattening was found. This subject, on being interrogated, testified that he always slept on his back; and his mother added the information that her son had slept on his back continuously from the first days of his infancy on, and had resisted all her efforts to get him to assume another position in bed.

The occipital protrusion among the subjects of the American Maronite series is typically strong and always quite normal (fig. 4, *e*, *f*).

I did not record all the asymmetries found on the American Maronite heads, but their number was very small indeed. Interestingly enough, the Lebanese Maronite series had the following percentages of cranial asymmetry: Absent, 80.43 per cent; Right, 10.33 per cent; Left, 9.24 per cent. On the basis of the observations of others, I should expect greater percentages. Pokrowskj (1900) concludes from his examination of skulls from cradling groups that the chief effect of cradling is cranial asymmetry (compare Field, 1948: 146). Le Gros Clark (1934: 50) remarks that asymmetries of the outer skull are, or at least can be, independent of asymmetries of the dural sinuses and the occipital lobes; i.e., the outer asymmetries should be mostly of external origin. There may be hereditarily conditioned asymmetries, also; at least, Weiss (1926: 263) describes two types he calls hereditary: one, a flattening of the right parietal in the rear, with an arching of the same bone anteriorly, and associated changes in near-by bones of the skull; and the second, a flattening of the left parietal, with a bulging out of the left frontal. Weiss (p. 262) claims these particular asymmetries are contracted during early fetal months. Frommolt and Caffier (1927: 53) observe much the same asymmetries: in general, a flattening of one parietal, an outward arching of the other, often with a reverse effect on the frontal bone. They opine (p. 57) that many asymmetries may be hereditary. I am suspicious of all this, to put the matter mildly. There are cranial asymmetries in all anthropoids (Leisewitz, 1906), but it remains to be proven that a particular asymmetry is actually hereditarily induced. Martin (1928: 743) holds that some asymmetries are inherited, but many are caused by external factors.

At all events, no one has ever even mentioned occipital flattening as possibly a hereditary asymmetry or deformation; some obstetricians (as we shall see in Chapter IV) have

associated a "Dinaric"-shaped head with certain positions in the uterus of the fetus, and with certain presentations. That is all.

The low percentage of asymmetries among the Lebanese Maronites is, so far as I can see (and anticipating my final verdict on occipital flattening), the result of efficient cradling on the part of the parents during the infancy of the child.

This digression on asymmetries aside, I wish to put down plainly the result of the observations pertinent to our problem on the two series of heads: the two kinds of heads are *totally different types.*

The Lebanese Maronites head is flattened in the back, the post-auricular length is abnormally short, the head has a "sugar-loaf" shape (Hooton, 1946: 602), typical of the Dinarics or Armenoids. There is usually a marked occipital torus, corroborating Hooton's (1930: 91) remarks on the Pecos Indians. Often, the head rises to a peak, or, better stated, the posterior plane of the head drops abruptly from a point well above lambda.

The American Maronite head is longish, moderately broad, fairly high; the post-auricular length is not remarkable for shortness or for great length; the occipital protusion is as normal as it is absent among the Lebanese. Quite generally, there is a definite lambdoidal flattening.

These differences are fairly well brought out in the photographs which compare Lebanese and American Maronite heads (fig. 4, *c–f*). These particular photographs were chosen because the subjects, Lebanese and American, possess the metrical average cephalic index for their two groups. The contrast would be, of course, still more striking in many other subjects.

The Metrical Results

Although more detailed subdivisions of the metrical data, e.g., according to types of flattening, might be desirable, still the comparison of the two series, each as a whole, is sufficiently striking. The metrical data confirm the conclusion from the observations; namely, that the Lebanese and American Maronite heads belong to two very different types.

These data are presented in table II.

One sees at first glance that the heads of the two series are startlingly different in head length, less so in head breadth, and very much less so in head height. The head circumference, as one should expect, changes considerably, following the head length. In the case of the cephalic index, it is the length that makes all the difference; the same statement holds true for the head height–head length index. In the face, the great change is in the bigonial. The facial index is not so markedly different, and the upper facial index is approximately the same. After these few very general remarks, we turn to the more detailed discussion of the data.

DISCUSSION OF THE RESULTS OF THE EXPERIMENT

Since the observational data need little more elucidation, I turn immediately to the metrical data.

Head Length. The head length varies the most of any measurement — a situation which is not unexpected in a comparison of a series exhibiting occipital flattening with one that shows normal occipital protrusion. The Lebanese Maronite head is shorter than its American counterpart by 13.555 millimeters. The x p.e. of the mean head length of the two series is 30.09 — a tremendous one.

This difference is greater than that found in any other study dealing with immigrants and their offspring, which has come to my attention.

The initial and well-known study in such a comparison was made by Boas (1911). In order to keep the relations of his findings to our own applicable, I consider only the differences noted among adult subjects. The greatest difference in the cephalic index was 2.5 points; this obtained for the combined series of Bohemians, Slovaks, Hungarians, and Poles, at the age of twenty-one, with 11 and 13 subjects, respectively, representing the foreign-born and the American-born. In this case I am particularly inclined to suspect differential infant treatment. In fact Boas himself later (1912: 554) wrote a sentence that could serve as the motto for this study: "I consider a further investigation into the influences of the

TABLE II: COMPARISON OF SERIES

MEASUREMENTS

Measurement		Lebanese Maronites	American Maronites	X P.E.
Head Length	M	176.84 ±.312	190.395 ±.325	30.09
	σ	6.66	6.29	
	V	3.77	3.301	
Head Breadth	M	156.26 ±.253	151.777 ±.300	11.42
	σ	5.42	5.817	
	V	3.47	3.83	
Head Height	M	131.03 ±.233	129.08 ±.251	5.68
	σ	4.95	4.76	
	V	3.78	3.69	
Circumference	M	547.84 ±.701	567.515 ±.850	17.86
	σ	14.97	15.585	
	V	2.73	2.75	
Minimum Frontal	M	105.52 ±.190	107.18 ±.212	5.82
	σ	4.06	4.072	
	V	3.85	3.80	
Bizygomatic	M	140.205 ±.224	139.515 ±.299	1.85
	σ	4.79	5.685	
	V	3.42	4.07	
Bigonial	M	110.04 ±.268	105.356 ±.310	11.43
	σ	5.74	5.95	
	V	5.22	5.65	
Total Facial Height	M	122.33 ±.282	125.15 ±.360	6.17
	σ	6.04	6.915	
	V	4.94	5.53	
Upper Facial Height	M	70.78 ±.207	72.18 ±.245	4.36
	σ	4.43	4.69	
	V	6.27	6.50	

INDICES

Index				
Cephalic	M	88.28 ±.206	79.17 ±.189	32.58
	σ	4.39	3.74	
	V	4.97	4.73	
Head Height-Length	M	74.19 ±.167	67.36 ±.154	30.06
	σ	3.53	2.95	
	V	4.76	4.37	
Head Height-Breadth	M	83.93 ±.177	84.42 ±.185	1.91
	σ	3.74	3.498	
	V	4.46	4.14	
Fronto-Parietal	M	67.79 ±.136	70.14 ±.165	10.99
	σ	2.90	3.14	
	V	4.28	4.47	
Cephalo-Facial	M	89.75 ±.151	91.595 ±.199	7.43
	σ	3.24	3.77	
	V	3.61	4.11	
Zygo-Frontal	M	75.49 ±.140	76.37 ±.140	4.45
	σ	3.00	2.67	
	V	3.98	3.49	
Fronto-Gonial	M	104.08 ±.280	98.16 ±.297	14.504
	σ	6.00	5.70	
	V	5.76	5.81	
Zygo-Gonial	M	78.58 ±.171	75.15 ±.206	12.81
	σ	3.67	3.92	
	V	4.68	5.22	
Total Facial	M	87.57 ±.256	89.39 ±.283	4.77
	σ	5.47	5.36	
	V	6.25	6.00	
Upper Facial	M	50.57 ±.161	51.02 ±.180	1.86
	σ	3.43	3.399	
	V	6.79	6.66	

method of bedding children desirable." In the age-class of twenty-six years and over, the difference in the cephalic index was 0.4 points, with 706 and 61 subjects, respectively, foreign-born and American-born. The Jews, foreign-born and American-born, differ by 1.6 points, the American-born being longer-headed. There are no adults in the Sicilian and Neapolitan groups. Boas, at the time (1911: 49), did not think that the methods of bedding the infant entered into the interpretation of his results. The peoples he investigated should be reworked, with more variables removed; infant treatment is one of the variables that should receive accurate attention.

The results of Boas' work were criticized by many, among the critics being Pearson and Tippett (1924). They found that English boys did not change in cephalic index from 4.5 years to 20.5 years of age (girls changed slightly) and concluded that the cephalic index was still a stable phenomenon in the anthropological cosmos. They also pointed out (p. 138) that the cephalic index of Jews all over Europe, in the most diverse environments, was stable; they could not believe that such a short time in the new environment of the United States could work any essential change. Morant and Samson (1936: 31) concluded that larger differences would have to be found in order to establish the theory that head form, as indicated by the cephalic index, was modified directly by environment. Auerbach (1912) pointed out that the cephalic index in Boas' subjects changed with the stature.

However, other workers have also found changes as between immigrants and their offspring. Guthe (1918: 223), for instance, registers a difference of –0.77 points in the cephalic index for males, comparing Russians born in Russia and in America. This is not an impressive contrast.

Two authors have studied the Japanese. Spier (1929: 7) obtains head lengths differing by as much as 3.4 millimeters among Japanese born in Japan and those born in the United States. His greatest difference in the cephalic index was 5.5 points, at the age of eight. I can not help suspecting that some disturbing external circumstance has entered into the picture. I say this in the light not only of other similar studies, but in that of my own findings and of all the literature I shall cite before the end of this investigation.

Shapiro (1939) observed a difference in head length between Japanese born in Hawaii and in Japan, those native to Japan being longer by 1.84 millimeters. The x p.e. between the head length of Hawaiian-born Japanese and the immigrants from Japan was 6.31. The difference in cephalic index was 2.6, being greater in the case of the Hawaiian-born Japanese; the x p.e. was 11.0. None of these differences, although notable in themselves, approach in magnitude the contrast I find between my Lebanese and American Maronites.

For Appleton (1927: 250), Chinese boys in Hawaii showed a difference in cephalic index of +0.13 over Chinese in Chekiang, and exactly the same over Chinese in Kiangsu, at the age of eighteen. Her numbers were small: 11 for Hawaii, 11 for Chekiang, and 15 for Kiangsu.

Goldstein (1943: 37) found no significant difference in the cephalic index of Mexican parents born in Mexico, and their children born in the United States. As for head length, American-born sons were 0.5 millimeters longer, on the average, than their Mexican-born fathers. Although I am restricting myself, as a rule, to evidence from male subjects, it might be mentioned here that the U. S.-born daughters of the Mexico-born mothers had a head length 2.1 millimeters shorter than their mothers.

Hirsch (1927: 81–83, 88) corroborated Boas' work on Jews, finding that the cephalic index was lowered 2.5 to 3 points, with a concomitant lengthening and narrowing of the head. I am definitely inclined to suspect infant treatment as entering into the picture here — in addition, naturally, to other possible factors, such as increased stature.

Finally, to bring this brief review of other findings concerning the comparison of immigrants and their descendants to a conclusion, we note that Boas (1924: 79) made a brief study of Armenians. This interests me very much, since the Armenians are cognate to the Maronites in their cradling customs. Boas, indeed, found a great decrease in the cephalic index between the two groups, and concludes that the difference in cradling was an essential point. I shall discuss this work more in detail in Chapter IV.

The combination of my findings with those of Boas creates, I think, the strong probability that some such disturbing factor as difference in cradling customs entered into the production of the large difference found by Spier in the Japanese.

But the point must be emphasized that no other series shows such a great difference, attributable to that mysterious factor called "environment," as do my Lebanese and American Maronite series, and here the difference is clearly due to one major variable. Even if I should whittle down the magnificent difference in head length and cephalic index exhibited by my two series, and remove one or two points of the index-difference because of difference in "environment," I still have a very large disparity indeed.

This difference is all the more striking, when I compare the change in head length with that in head breadth. The latter changes absolutely and relatively little. The effect of cradling on the Maronite head is primarily to reduce the length; this statement also holds, when I consider the head height. Both these measurements will be regarded with greater scrutiny in a moment.

Several other possible reservations conceivably affecting the sharp focus of the picture presented by the metrical data with regard to the vault measurements and especially the head length must be examined here.

The first of these is the correlation of head length with stature. That such a correlation exists, within given populations, has been quite generally established by various authors, working on various groups. Martin (1928: 783) mentions Germans, the people of Baden, Tirolese, French, Russians, Italians, Swedes, Gypsies, and Papuans. Pittard (1905; 1911; 1935; Pittard and Donici, 1927) makes a great deal of this phenomenon in numerous papers. Johannsen (1907: 183) emphasizes the point that this greater tendency towards dolichocephaly exhibited by the taller subjects is due to the greater absolute head length of these taller people. Certainly in an accurate and complete study of a population, the relationships of stature and head length should not be disregarded, although many of the correlation coefficients are small, and the picture may often be confused (Sacchetti, 1942).

Exceptions to this tendency have occasionally been noted. The most interesting I have seen is that of de Froe (1938: 29), who worked on Dutch skulls, which were documented with cadaveric length, sex, etc. He finds that cadaveric length correlates very poorly with skull length and breadth, although well with various measurements of the skull base, and concludes: "We zien dus, dat het schedeldak d.i. het grootste deel van den beenigen hersenschedel, zich onafhankelijk van de lichaamslengte ontwikkelt." Hrdlička (1935: 288) finds that the head length is somewhat increased with increasing stature, though not proportionately. It does not keep pace with stature in Egyptians and Old Americans. Saller (1930: 49) has some interesting figures for his Fehmarn male subjects: the correlation coefficient for stature and head length is 0.291; for stature and head length arrayed according to percentages of stature, –0.53; for stature and head breadth, 0.24; for stature and cephalic index, –0.05. The last figure is very important.

The correlation coefficient for stature-head length among the Lebanese Maronites is 0.194, not an impressive one. Unfortunately, I have no data on stature for the American series. But the probability that they are somewhat taller than their parents is strong. An increase of stature in American-born of various groups over that of their ancestors has been found by Boas (1911) for Jews, Bohemians (but not for Italians); by Fishberg (Morant and Samson, 1936) for Jews; by Spier (1929) and Shapiro (1939) for Japanese in America and Hawaii; by Appleton (1927) for Chinese.

That some of this increase in stature is connected with betterment of social and dietary conditions is proposed at length (with much literature) by Sanders (1934: 219–95). I do not think that the probably existing increase in stature of American over Lebanese Maronites would be extremely marked, if these causes alone were operative. The conditions of life for the immigrants when the subjects of my American series were born and raised were not too favorable. Rural people are generally taller than urban folk: the Maronites are urban to a man. The well-to-do are taller than the less well-to-do; my Maronites are variable in this respect, but I hazard the opinion that the majority were less well-to-do

twenty-one to fifty years ago. The professional class is taller than the middle class: my Maronites are not notable for an excess of professional men. There is no reason to attribute to them a state of health markedly better than the average. Nor, finally, do I have any reason to suspect that the percentage of ectomorphs suddenly became overwhelming among them.

In any case, even if the American Maronites are somewhat taller than their Lebanese ancestors, this fact would not endow them with a markedly greater head length or lower cephalic index. The differences between different stature-groups in the investigations cited do not extend, *at their greatest*, to more than two points in the cephalic index. The average stature of the Lebanese Maronites puts them in the medium-tall category (160.0–169.6 centimeters). An increment of even 2 centimeters (and I doubt, from observation, that the gain would be that great), would merely carry them into the tall category, with a probable change of a digit behind the decimal point in the cephalic index. Certainly, increase in stature could never be in any way correlated with the tremendous difference I obtain, precisely in head length and cephalic index (compare magnitudes in Sacchetti, 1942), not elsewhere.

Even if I were to consider reducing the magnitude of the difference I obtain in head length and cephalic index, I should not have to reduce it anew for each of the variables I am here considering, since they all fall under the heading of that catch-all category, "environment."

So, too, in some part, does the difference observed by some between dwellers in the country and in the city. Ammon (1899) found that the Baden people in the cities were more dolichocephalic than those in the country. Could infant treatment also enter into the process? Pessler (1939: 227–28) found differences, but not impressive ones: the head, in the cities, is 0.7 millimeters shorter, and 0.9 millimeters narrower, the cephalic index, 1.2 points lower. He also found (p. 247) that the children of both city and country groups were more dolichocephalic than their parents; however, the children differ more from their parents in the country. Not all the differences he found are statistically significant, but they all point towards an action of some kind on the head form by "city life." Pessler (p. 248) advances some very tentative hypotheses for explaining this phenomenon: earlier puberty and quicker growth among them; Martin (1928: 792) is content to leave the whole thing to "Selektive Prozesse."

The influence of food is no doubt also to be included among the variables. The work of Iwanowsky (1925) on famine-sufferers, and various experimental work on animals, will be discussed in Chapter IV. For the moment, I shall only remark that the food in the Lebanon is adequate, but as a rule simpler than in America. In the absence of accurate data, such as weighed and analyzed meals, I can say little more.

There is no rampant disease among the Lebanese Maronites which could, by any stretch of the imagination, explain their flattened occiputs by its presence, and, by its absence, the normal heads of their children in America. Some idea of the diseases which are common in the Lebanon is afforded by the official government statistics (*Recueil de Statistiques*, 1942–43: 54). This source is rendered less than ideally useful by the fact that physicians are not required by law to turn in records of their cases to the Government, but may do so if they wish. With this proviso in mind, we note that the most common contagious diseases occur in the following order, according to frequency of incidence: trachoma, typhoid and paratyphoid, smallpox, dysentery, scarlet fever. The causes of death listed in the same way are (p. 58): (not specified), diseases of the digestive apparatus, diseases of the circulatory apparatus, of the respiratory apparatus, senility, infectious and parasitic diseases, genito-urinary diseases, cancer and tumor, rheumatic-nutritional-endocrine diseases, children's diseases. It seems very possible to me that better infant and subsequent hygiene here in America has allowed the persistence in life of a number of ectomorphs, who add considerably to the average stature of the American Maronites. But I cannot, at the moment, substantiate this opinion.

To sum up: The vast difference in head length and cephalic index and head form between the Lebanese and American Maronites can be conceivably lessened to a minor degree

by one or more of the variables I have discussed. But there is only one factor that can claim to have created that great difference — the fact that the Lebanese Maronites were cradled during infancy in the traditional manner, and the American Maronites were not so treated.

With regard to this cradling, we still have one final variable to consider. I have mentioned the custom, among the American Maronites, of swaddling the infant for two to three months after birth. I was worried by this practice, at first. However, I finally came to the conclusion that this custom made little or no difference. The reasons for this conclusion were two: the fact that the Detroit subjects (in Detroit the custom is admittedly universal, even in the second and third generation) had even a slightly lower cephalic index and head length than the other American Maronites; and secondly, the strong probability that many American-born children of other extractions are somewhat affected by ordinary bedding during the first months of infancy. The basis for this second reason will be found in the literature I shall discuss in Chapter IV.

Head Breadth. The difference in head breadth between the Lebanese and American Maronites is only 4.48 millimeters. The x p.e. is 11.42 — large, but not comparable in magnitude with that of the head length. It is interesting to note that Melconian and Schaepelynck (1947: 50) also found the principal difference to be in the head length, when they compared their small series of "normal" and "deformed" skulls from the Lebanon.

It is possible that the lambdoidal flattening observed on so many of the American series has something to do with this "retention" of head breadth, but I am not prepared to state this as a fact. I doubt that the effect of this small, localized flattening is marked.

It is interesting, if merely speculative, to note that, if one were to construct an ellipse whose long axis were the average head length of the Lebanese Maronites, and the short axis their head breadth, and were then to lengthen the long axis to the head length of the American Maronites, but keep the area unchanged, the short axis would be only 143.7 millimeters, instead of the actual head breadth of the American Maronites, of 151.7 millimeters. Compensation obviously does not occur in the areas registered for us by the ordinary measurements.

However that may be, the head breadth, although extremely variable within a group (Tschepourkowsky, 1911; Pearson, 1897) as a rule, appears to be a sober diameter, considered with regard to growth. So Weissenberg (1908: 315) writes: ". . . nicht alle Teile sich gleich intensiv entwickeln, indem auch in dieser Beziehung die Kopfmasse die geringere und die Gesichtsmasse die stärkere Zunahme zeigen. An den Polen stehen die Kopfbreite mit der geringsten Wachstumsenergie, und die Nasenhöhe mit der starksten." And Vilas (1929: 712): "Die grösste Länge nimmt während der Entwicklung, entsprechend der Beständigkeit des LBI, verhältnismässig stärker zu als die grösste Breite." An idea of the interracial variability of head breadth can be gained from the fact that its range is 72 millimeters (Bartels, 1904). Martin (1928: 767) attributes brachycephaly primarily to the greater breadth of the head, at least for the majority of brachycephals. This fact will reappear in another context in Chapter IV. The point I want once more to make here is that in the case of the Lebanese compared with the American Maronites, it is not the head breadth but the length that makes most of the difference.

Cephalic Index. It is the head length that primarily affects the extravagantly divergent cephalic indices for the two groups, between which we have the exorbitant x p.e. of 32.58. In a small series (N: 25 each) of fathers and sons, whose head lengths and breadth I recorded while studying the American Maronite series, I obtain a similar result: of these twenty-five, the sons (American-born) yielded an average cephalic index of 78.7, the immigrant (Lebanese) fathers, one of 89.2.

Head Height. The rather small change in head height is surprising, especially when one recalls the impression of hypsicephaly given by many Maronites of the Lebanon. Melconian and Schaepelynck (1947: 51) found increased head height in a small group of "deformed" as opposed to "normal" Lebanese skulls. But even allowing for the deplorable difference in techniques employed on the two groups, the results may indicate that the differ-

ence in head height may not be so striking, in large series, as one should expect. I am in a position to propose only tentative opinions on this subject, but these opinions are: (a) measurements of two series like mine with the same technique would show a greater change in head height, and (b) this change would not be the startling one anticipated. The reason for the second opinion is the result of numerous morphological observations on Lebanese Maronite skulls and living heads to the effect that in planoccipital subjects there is considerably more fullness in the supralambdoidal region. Much of the compensation, therefore, would occur in the very rear of the head, posterior either to bregma or vertex. Another area of compensation would be the descended posterior cranial fossa. That a down-curving of the lower occipital bone takes place in hyperbrachycephalic skulls has been noted by craniologists, and has entered medical literature, in connection with landmarks of the head and neck. Thus, Goldhamer and Schuller (1927: 1175), dealing with Austrian skulls, remarks on the deepening of the "hinteren Schädelgrube," in the case of hyperbrachycephals. I have observed this same effect myself, in studying a number of X-rays of Maronite heads at the Medical School of the American University of Beirût, through the kindness of Dr. Richard Kegel.

On the whole, the trend of my present opinion — that the deformation of occipital flattening affects largely the rear portion of the head — is consistent with the findings of a number of craniologists. I shall discuss their findings at length in Chapter IV, to which chapter I should like to confine consideration of the literature.

Head Circumference. This measurement adds little important knowledge to our survey of the comparative situation of Lebanese and American Maronite heads. The x p.e. between the two means, 17.87, is large enough, to be sure, although little more than half of that obtained between the head lengths. This measurement primarily reflects the shortening of the head due to flattening.

Minimum Frontal. We should consider, in addition to the essential discussion of the vault dimensions, a subsidiary set of remarks on the face. In this section, I have three background ideas: (1) the racial continuity or discontinuity between the two types; (2) any changes that might reflect differences in environment; and (3) any changes which would reflect the influence of occipital flattening.

The first measurement I shall consider, the minimum frontal, bridges, as it were, the discussions of the head and the face. The difference between the two series with respect to this measurement turns out to be an intriguing one, especially when compared with the other brain-case dimensions and with those of the face.

The American Maronites have a broader minimum frontal, being larger by 1.66 millimeters in the mean. The x p.e. shows a significant difference (it is 5.82); I can see no reason why this should be the case. Nor am I unduly concerned about the significance. Certainly, occipital flattening does not noticeably affect the forehead, in so far as the forehead may be characterized by the minimum frontal measurement. Both the present fact and my observations do not agree with the conclusions of Pruner-Bey (1866: 566), who stated that flattening had changed Syrian skulls from dolichocephaly to hyperbrachycephaly, and had also forced out the forehead (made it "bombé") and increased the width across the zygomatic arches. Hooton (1930: 49) found the minimum frontal of deformed and undeformed Pecos skulls practically identical.

This measurement is reflected in the frontoparietal index, together with the head breadth; and in the zygo-frontal index, with the bizygomatic diameter. The changes here are what one should expect, given the measurements.

Bizygomatic and Upper Face Height. In view of the striking difference in the bigonial diameter, we should expect that the bizygomatic should also register a change as between the Lebanese and American Maronites. However, the Lebanese series averages only 0.69 millimeters larger in this diameter, and the x p.e., 1.84, is the smallest of any in our listing of statistical data. I am secure in stating that the measuring technique in this case should have been quite comparable for both series.

The upper face height, too, differs relatively little. I say this in spite of the 1.4 millimeters difference and the x p.e. of 4.17, because I am aware of the difficulties of accurately deter-

mining the upper point of this diameter, the nasion, under all conditions of measurement in the field. The upper facial index is consoling, with an x p.e. of only 1.86 as between the two series.

The consensus of anthropological literature, examples of which will be cited in Chapter IV, is in favor of the opinion that the face remains unchanged, when deformed and undeformed heads are compared. This opinion seems to be corroborated by the comparison of Lebanese and American Maronite upper faces.

Bigonial and Total Facial Height. In the bigonial diameter we find the greatest difference, except for the head length, between the two series. The American mean is 4.68 millimeters smaller than that of the Lebanese, and the x p.e. is 11.43. The salient point of contrast between Lebanese and American Maronite faces lies in the posterior breadth of the mandible.

When we review the literature concerning the development of the mandible and the general question of the relative influences of muscle and bone, we are in a position to understand how this situation might have arisen.

Ćwirko-Godycki (1928: 167) concludes from his comparative study of well-muscled and less well-muscled skulls, that one must especially note the correlation of the gonio-zygomatic index (what is here called the zygo-gonial index) with the index of contractile force of the muscles, which he reckons from the thickness and breadth of the various muscles. His work seems to indicate, in general, that the heavier, more robust skulls have heavier, more robust muscles, and who is there to wonder at this conclusion?

Scott (1938: 933) made experiments on the growth of the mandible in the dog, and concludes: "The greatest amount of growth took place in a region in which the most powerful of the muscles of mastication have their sites of attachment. This supports the hypothesis of Thoma that muscle activity is the most powerful extrinsic influence in development of the length of the jaw."

Thoma himself (1938) quotes with approval Walkhoff's (1903: 129) experiment in which he excised a portion of the temporal muscle in a dog; he concludes his paper with the statement that the development of the mandible is influenced primarily by muscular function and the associated increase in blood circulation; but the maxilla is not by any means so dependent on the muscles. This is enlightening, for in the case of our Maronites, the upper face remains unchanged when compared with the mandible.

Klatsky (1940: 668) descants on the difference hard and soft food make to the development of the jaw, and says (p. 669) that the bone is dominated by the muscle. He quotes with approval what Keith (1925: 671) writes: "In the inhabitants of our western cities the biting mechanism has fallen into disuse. The overlapping incisor bite has appeared. The cheeks, which are high and prominent when the biting muscles — the masseter and internal pterygoid — are well developed, become reduced and sunken, giving our very narrow, hatchet-shaped faces — our oval cast of countenance." I cannot completely agree with the whole of this statement, on the basis of my findings in this study, since the zygomatic arches do not seem to have "degenerated" as much as they should.

There is considerable difference, however, between the food of the Lebanese and American Maronites. This difference may be found particularly in the greater toughness and roughness of the food in the Lebanon; but at the same time, I do not want to overemphasize this difference. It lies chiefly in the bread.

Waugh (1934: 445) states that the Eskimos' large jaws and regular teeth are due to unusual masticatory activity. Waugh is not without predecessors in this opinion. However, Lewis (1938: 11) remarks on the Arabs, with a diet of milk and dates, and the Africans who feed on porridge, and who yet have fine teeth and facial development; although he admits there must be some sort of association between habits and changes in the skeleton. Hooton (1946: 492), who recognized the fact that the Eskimo skull is not shaped by the chewing of hides, writes: "Stefansson thinks that the Eskimo use their teeth in feats of strength because they happen to have inherited strong jaws, rather than that their jaws become strong through usage. This seems plausible." However, the same author (p. 504) admits that "The use of the teeth in chewing may modify the proportions of the face. Strong-jawed people are likely to have broad faces. . . . It may be that the modern dietary of soft, cooked food has

brought about a partial atrophy of the chewing muscles affixed to the sides of the face and the brain-case, thus diminishing face breadth. By way of compensation, the face may elongate or grow downward along the line of least resistance. This tendency toward lengthening and narrowing of the facial skeleton is certainly pronounced in northwestern Europeans and *in many of their American relatives*, but it is by no means as widespread in modern groups as the broadening and relative shortening of the brain-case." (Italics are mine.)

Friel (1926) holds that we cannot wholly dissociate maldevelopment of the jaws from weak musculature. Lewis (1938: 16) points to the remarkable work of Rogers in correcting malformations of the jaw and dental arches with muscular exercises, and concludes: ". . . while as yet we have relatively little proof of the part played by function in determining the growth and development of the face, clinical observations indicate that in some manner and in some degree function, broadly defined, plays an important role in furthering or impeding the inherent factors that produce the adult facial pattern."

Rohde (1940: 1029) calls attention to the usually unrecognized importance of the muscles of deglutition and thinks these are even more important than the muscles of mastication in developmental stimulation. He also (p. 1033) emphasizes the importance of the muscles of mastication and deglutition as opponents of the whole group of post-cervical muscles. An informative study would be a comparison of the anterior neck muscles and jaw muscles of dolichocephalic as opposed to brachycephalic peoples.

An interesting and modern discussion of the relations of muscles and bones and Wolff's Law is given by Mainland (1945). On page 83, he reformulates Wolff's Law thus: "After the main form and structure of a bone has been developed as a result of its internal (inherent) properties, its finer details and later modifications are due largely to external forces." Or, in a more generalized form: "After its first formation, bone is built and unbuilt largely in response to demands made on it, these demands including the need for rigidity, for mineral supplies, and for blood cells." And Weinmann and Sicher (1947: 121) well say: "Forces which are within the limits of tolerance will act to stimulate bone apposition if they are applied to particular regions, and in such directions that they can be regarded as intensified normal forces."

The teeth, too, have their place in this picture. Du Bois (1911) ground down the teeth of animals on one side, and noted asymmetries in the skulls as a consequence of his interference with nature. I have no data on the size of the teeth, percentages of malocclusions, etc., on the American Maronite teeth. But Hughes (1938a: 1066) finds no essential difference in the percentages of occlusal anomalies of Asiatic and American Armenians, a people not too far removed from the subjects of our study. However, he remarks (p. 1069) that not all malocclusions are hereditary — many seem to result from sucking habits, poor nutrition, retarded growth, etc. Hence, a necessary parity cannot be established. Cieszyński (1935: 319), as a matter of fact, claims that the teeth have no influence at all on the bones of the entire jaw, but that they themselves depend for size and shape on muscular function. This seems implausible. But Weinmann and Sicher (1947: 97) assert that the influence of the teeth on the growth of the bone of the mandible is slight (except in the region of the alveolar processes), whereas the influence of bone growth on the development and eruption of the teeth is very great.

However, the influence of change of diet on the whole shape of the mandible and on occlusal malformations must not be underestimated. Price (1939), although primarily interested in teeth, notes the narrowing of the dental arches and of faces as a result, it would appear, of the change from "primitive" and wholesome diets to modern white diet. Making due allowances for racial factors, and for the fact that the change from a Lebanese diet to an American city diet is not so radical as the change from a primitive diet to a partial white diet, Price's findings still have some application here. Particularly illuminating are his remarks on bread (pp. 276–78), since the Lebanese bread supplies all the minerals and other ingredients of whole-wheat, plus exercise for the chewing muscles.

Toverud (1933: 93–94) remarks on the lateral compression of the jaw, which may

often be traced to an early rachitic period in the life of the individual, but which often seems conditioned even earlier (prenatally?). He wonders whether this may not be due to craniotabes. It would be difficult apodictically to rule out deficiencies in the American Maronite diet, especially during gestation and early infancy; all I can say is that, except for this possibility in the narrow lower jaw, no signs of such deficiencies are notable.

The racial factor is a possible complication in this question of the narrowing of the lower jaw. It is true, indeed, that the percentage of Classic Mediterranean in the American series seems to be slightly larger than in the Lebanese series. However, this does not affect the average breadth of the face, as indicated by the bizygomatic diameter, or the height of the upper face. In any case, I wish to reiterate the statement that the American Maronite subjects were children of Lebanese Maronites from the same stock and the same area as those of the original Lebanese series. The small Father-Son series helps to bridge the gap between the two countries. Comparison of the photographs of the two main series used in this study (fig. 4, *c–f*) strongly suggests that the Americans are less rugged-looking, more smoothed-down, than the Lebanese. This situation can be due only to the results of difference of function, so far as I can see.

The literature cited has shown the potency of the influence of function. All that function need do for me, at this moment, is make intelligible an average change of 4.68 millimeters in the breadth of the rear portion of the mandible; a breadth which can include rugosities of bone which obviously seem to be correlated in size with muscular tensions; a breadth of the mandible, which Cleaver (1937: 110) found to be rather more variable in a group, relative to size, than even the cranium. Finally, this lessened breadth is found in subjects whose head breadth is markedly less than that of their ancestors.

The total face height is 2.82 millimeters larger in the case of the American Maronites than in that of the Lebanese Maronites. The x p.e., 6.17, is large. But, the total face height includes a difference in the upper face height, whereby the American series is 1.4 millimeters larger than the Lebanese series. That leaves a somewhat smaller difference to discuss.

It seems quite probable that the height of the mandible has increased somewhat, in favor of the American series. However, it is impossible to be accurate about this. I did not take observations on the bite for the American series, and even if I had, I could not be accurate even when in possession of this information. The Lebanese series did not have abnormal percentages of types of bite. It showed: 71.2 per cent of over; 25.54 per cent of edge-to-edge; 2.17 per cent of small under; 1.09 per cent of under. A possible reduction in the percentage of edge-to-edge may be possible among the American Maronites. It is also very possible that the wear on their teeth is somewhat less than was shown by the teeth of the Lebanese series, which, however, was not excessive in that respect. The total face height could also be affected by the probably greater percentage of ectomorphs preserved for the American series by more efficient infant hygiene. There would also exist the tendency of this measurement to correlate with the increased stature that I must almost take for granted in the American Maronites. Finally, the total face height is a dangerously complex measurement. I find too many unknowns in the problem to be able to make any more definite statements about the total face height.

IMMEDIATE CONCLUSIONS FROM THE EXPERIMENT

The conclusions to be drawn from this experiment in comparative anthropometry are few and simple.

(1) Cradling, as practised by the Lebanese Maronites causes a great change in the head form; viz., from mesocephaly to hyperbrachycephaly, from normal occipital protrusion to strong occipital or lambdo-occipital flattening. These changes are registered in a greatly increased cephalic index, a greatly decreased head length, some increase in head breadth, and possibly only a small increase in head height.

(2) The changes effected by cradling are primarily noticeable in the posterior portion of the brain case.

(3) It is not clear that these changes are correlated with any changes in the face.

GENERALIZATION OF THE EXPERIMENT

INTENTION OF THIS CHAPTER

THE results obtained from the comparative study of the Lebanese and American Maronite series are of such interest, that it became inevitable that the anthropological data garnered from the various peoples and areas of the world be examined, in an effort to ascertain whether our results might not find corroboration and further illumination from groups other than the Maronites. It would indeed be extraordinary if the Maronites were alone in exhibiting interesting effects of early postnatal infant treatment.

In this chapter, therefore, I shall present the data relevant to the generalization of the results of my experiment, in the form of a comparison of the distribution of hyperbrachycephaly and of cradling or its equivalent. If correlation between these two phenomena be established, strong probability would be created for adhering to the opinion that there is a causal connection between the two wherever found. In addition, this chapter joins Chapter IV, which will be concerned with the literature pertinent to our problem, in offering further knowledge of the conditions and limitations of infant treatment with relation to head form.

GENERAL CONSIDERATIONS

The most economically efficient manner of presenting the numerous data necessary for even a preliminary study of the possible correlation between hyperbrachycephaly and cradling or its equivalent is that of assembling the patterns in map form. Since the Maronites are located in Asia, and since my first perception of any possibility of diffusion of cradling and its correlation with hyperbrachycephaly came from a consideration of that continent, one of my supporting maps (fig. 5) is devoted to the distribution of high cephalic indices there. Europe not only harbors many short-headed peoples, but actually forms one continent with Asia; it is, in addition, of special interest to most modern Americans. The other supporting map (fig. 6) is, therefore, devoted to this area.

All the data for the supporting maps are taken from Gerhardt (1937–38), except those with added initials, derived from the following authors:

C & B — Chantre and Bourdaret, 1902
H — Hagen, 1898
J — Jochelson, 1928
K — Kubo, 1913
L — Lopatin, 1937
M — Martin, 1928
Mo — Mondière, 1882–83
P — Porotow, 1895
S — Schendrikowskj, 1894
T — Torii, 1913–15

The situation of the aboriginal Americas is simplified, for us, by the many practises of intentional and easily recognizable cranial deformation; it is also immediately under our eyes. These two continents, therefore, need no supporting maps. Africa and Australia are also unrepresented, by default of material for our thesis.

The world map (fig. 7) exhibits, in very general lines, the world distribution of hyperbrachycephaly, according to recorded averages of the cephalic index. It is not possible, in a study based on existing data, to make this an ideal map. One cannot, for instance, always distinguish with certainty between plan- and curvoccipital types of hyperbrachycephalic heads. However, it will become increasingly probable, as this study progresses, that not necessarily all "deformed" heads must be flat in the back. The influence of the early postnatal treatment of the infant does not stop at a certain geometrical form or term, any more than it comes to a halt when a certain index is reached. One of the intrinsic difficulties in the presentation of a world-wide study is the complex variability of effect of the factors we are discussing. This variability is all the more exasperating, because an accurate assessment

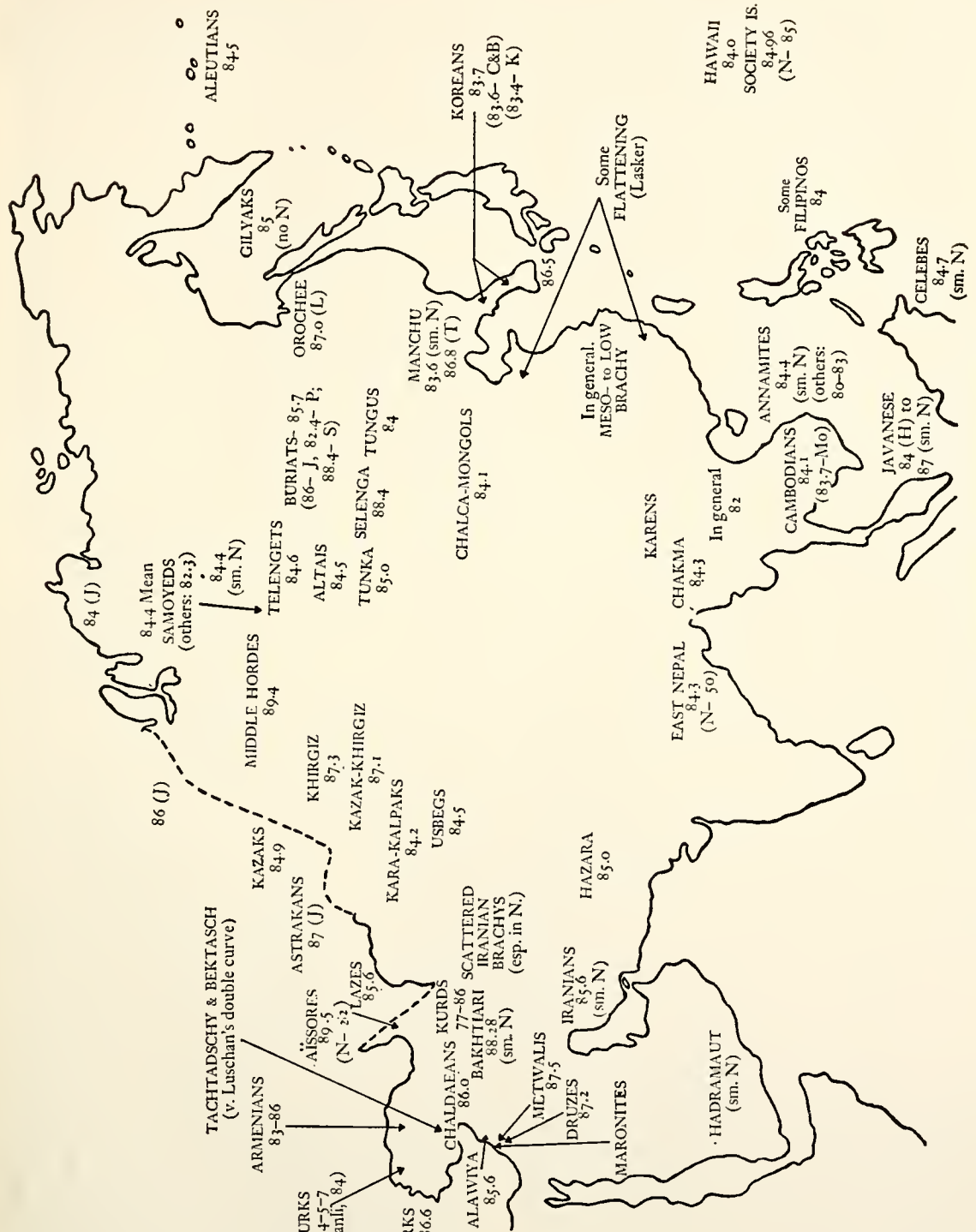


FIG. 5. Map of Asia, showing distribution of hyperbrachycephaly.

Fig. 6. Map of Europe, showing distribution of hyperbrachycephaly.

of its conditioning is impossible at the moment. Remarks on cradling, for instance, in the literature are almost always of the utmost vagueness. Important variations in custom are mentioned, if at all, very casually.

There is much variety in methods of cradling and in the application of recorded methods. Thus, to establish the fact of "cradling" in an area does not automatically make the people of that region candidates for average hyperbrachycephaly. The actual method itself may be more or less efficient with respect to head-shortening; so, for example, the most widespread form of cradleboard of the American Indians, that designed to be carried vertically, is not conducive to notable brachycephaly. The type employed by some southwestern Indians, which is carried horizontally most of the time, is very conducive. Again, there are areas in which no form of cradling is practised, but an equivalently efficient custom flourishes.

Even among the groups which have an effective form of cradling, the differentials are multitudinous. Such differentials may be: those arising from use or non-use by various social classes; the various materials of which the cradle, and especially the "pillow," may be made; individual variations in adherence to local custom; idiosyncratic characteristics of the infant; intrinsic differences in the constitution of the infants' skull bones; sundry pathological factors. Examples of many of these confusing variables will occur in the discussion of the areas of the world and in Chapter IV. Simply to underline the idea of differentials at this point, I may ask several questions. What idea of the efficacy of Pimo cradling could we have, had not Mason (1889: 184) casually mentioned that the infant in that tribe is cradled until he is capable of supporting himself on his legs, whereupon he is made to stand on the bark cincture of his mother and clasp her neck with his little arms? How can we expect anything else than variability in Navaho occipitals, when Leighton and Kluckhohn (1947: 22–23) tell us that the amount of time the Navaho baby stays in the cradle varies with its temperament and with the situation of its mother, e.g., whether she has older children to help her or not? Are we to expect uniform results from Hopi cradling, after learning from Dennis (1940: 33) that "The duration of the cradle usage depends in part upon the restlessness of the child and in part upon his motor development"? The catalogue of variation in custom in the cradling areas of the world is lengthy, as witness the rather haphazard record of observation in such a work as that of Ploss (1884, II).

With regard to the registration of the cephalic index, I have tried on the world map (fig. 7) to avoid the Scylla of placing the dividing line between brachycephaly and hyperbrachycephaly too high, and thereby omitting relevant data, and the Charybdis of placing it too low, thereby invading the field of what I must presume to be legitimate brachycephaly. My compromise was 84. Now that the work is done, I am strongly of the opinion that I erred on the side of caution, for much brachycephaly under 84 seems also to be culturally conditioned. However, I leave the cautious error as it stands, for my caution but strengthens the case.

I am forced to deal with the arithmetic mean; but that does not mean that I am unaware of its limitations, both in general, and as conducive to a sharp, truthful focus of the picture of the phenomena I am presenting. The nature of the arithmetic mean is another reason why the world map and the conclusions from this chapter must of necessity be presented along broad lines. Fortunately, certain areas are given some further illumination by the use of groupings of subjects into categories such as dolichocephalic, mesocephalic, brachycephalic, and hyperbrachycephalic. A respectable percentage of both of the last two classes might indicate that cradling methods, which are not universally used in a population and which would not always have identical effect even if they were, are having their effect on a share of the infants.

If, however, we can hope for nothing better than a set of general ideas from this distribution study, yet I think we shall succeed in heaping up such a large number of fairly clear-cut cases of the influence of early postnatal infant treatment on the cephalic index in many areas, that these — taken in conjunction with the results of our experiment — will add immeasurably to the probability of a causal connection. This probability will be increased

by the knowledge that every little patch on the map, outside the main areas of hyperbrachycephaly, seems to be provided with some method of applying external forces to the head which would explain the short-headedness of the region.

In this discussion I am not entering into the question of really ancient deformations. I am restricting myself to recent peoples, about whose customs something authentic can be learned. I shall not, however, delay on areas in which intentional artificial deformation of the head is practised, particularly when the means of such deformation are definite and clear. The literature on the subject is sufficiently expansive to allow me to take it for granted.

Having posited these general remarks, I can turn to the detailed examination of the pertinent parts of the world.

THE DISTRIBUTION MAP BY AREAS

The world map (fig. 7) of the distribution of hyperbrachycephaly has been supplied with numbers. These numbers indicate the specific areas, which I shall now proceed to discuss.

(1) Australia. The type of cradle, if it may be so denominated, in use in Australia is what Pflug (1923: 186) calls the "Holztrog," which is a dugout vessel, made of wood, into which the infant is placed. This sort of receptacle is also found in Borneo and the Celebes, and among the Ainu. Dr. Joseph Birdsell tells me (personal communication) that this "Holztrog" is merely a vessel, among the Australians; it is used for many purposes besides holding the baby, and the infant does not spend much time in it and is not forced to assume any particular position in it. A large part of the time the baby is carried astride the mother's hip, as in many other parts of the world. There is no preparation for fastening the infant into the "Holztrog." There is no hyperbrachycephaly among the Australians.

(2) Borneo and the Celebes. In these areas, there is considerable intentional cranial deformation (Dingwall, 1931: 124–29; Ploss, 1884, I: 318). The "Holztrog" is also in use here, as remarked already (Pflug, 1923: 187), but any possible effect of its use is masked by the deforming custom and apparatus.

(3) Java, etc. For this area I have no data on cradling, but in lieu of this one may glean scattered information from Dingwall (1931: 122–23) on head deformation, here and there throughout Indonesia, which is enlightening. And all through this area the custom of sleeping on fairly hard surfaces and tough, woven pandanus and bamboo mats should be contributory to brachycephaly on the part of a large number of people. Porter (1889: 231) quotes Forbes on the custom, among the Timor-Laut, of laying the newborn infant on "a hard palm spathe," which is spread in a rough rattan basket; and on the more adult custom of sleeping on bamboo mats, with a piece of squared bamboo for a pillow; Porter also quotes Garson, who remarks on the flattening of the Timor-Laut skulls. This is the sort of thing that goes on throughout the area. The effect of manual massaging of the head on that little patch of hyperbrachycephaly around the Torres Straits (Dingwall, 1931: 132–33) is also very probably meaningful. Serious observers seem convinced that such manipulation, if carried out with intention and perseverance over a considerable length of time, has permanent effect on the head. I suspect that the bedding of the infant on fairly hard surfaces at least assists this manipulation in efficacious change of the infant head form.

(4) The Philippines. As a result of my observations, I do not believe that active cranial deformation is currently practised in the Philippines, but the custom was once quite widespread (Meyer, 1881; 1884; Bauer, 1900). The effect of early bedding on fairly hard surfaces is clear to me from my experience in this area. In comparing various groups in the southern Philippines, I found more occipital flattening and higher brachycephaly in groups that laid their infants on mats (usually on the split-bamboo floors) than among those who used cloth hammocks. The idea that early bedding has a causal effect on occipital flattening is shared by Bean (1909: 403–05), who also studied Filipinos; he is particularly of this opinion, because flattening cuts across his classification lines.

(5) The Ainu. We have already remarked that the "Holztrog" (Pflug, 1923: 186) ex-

tended to the Ainu. Murdock (1934: 179) merely notes that the baby is put into the cradle, which is suspended from a beam. Putting the baby in a cradle suspended from a beam evidently is not particularly deformative of the head, of necessity; the same description goes for Scandinavia, and there is no special effect. Porter (1889: 229) quotes a Japanese to the effect that the child is carried on the back of its mother, as soon as it can clasp the body of its parent with its legs. Just how old it would be at this juncture, I am not certain. At all events, the flattening effects of floor-sleeping would not be great, as the child is

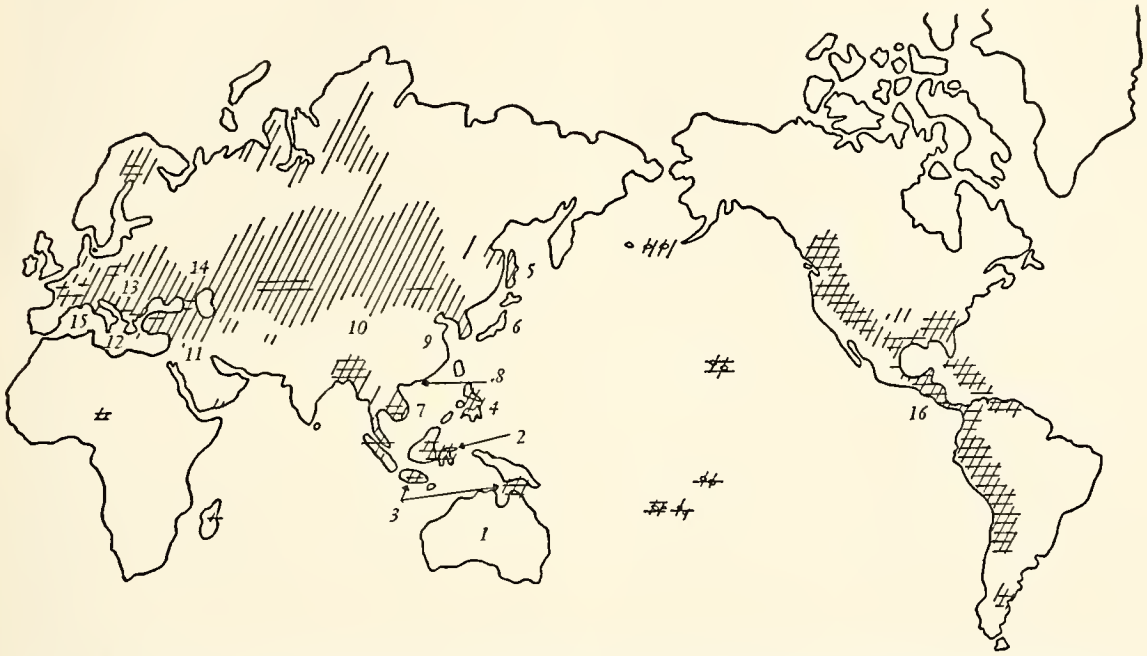


FIG. 7. World map of the distribution of hyperbrachycephaly, indicated by hatching (the horizontal lines mark areas in which intentional artificial cranial deformation conducive to the production of hyperbrachycephaly is practised).

evidence of deformation in that region. It is irritating, however, to have so little information about customs like this.

(6) The Japanese. These people are brachycephalic (Matsumura, 1925) but I mention them here because of a remark of Dr. Franz Weidenreich at the December, 1946, meeting of the A.A.P.A. He predicated small amounts of occipital flattening of the Japanese, referring to a yet unpublished paper of his. The Japanese, as I have learned from several persons who have lived and observed there, lay their infants on the floor, which is typically of rather pliable matting, placing a cloth or a thin quilt under the babies' bodies. If the infant lies on the floor on its back, which it would normally do for at least four to five months, the floor could have some flattening not tightly swaddled or otherwise rendered immobile.

(7) The Cambodians, etc. Deformation also occurs in Cambodia, but a mixture of parietal flattening (Dingwall, 1931: 97), the custom of placing the infant on a mat on the floor, and the very early and continuous use of turbans by male children, makes the analysis of this part of the world somewhat obscure. The Burmese (Dingwall, 1931: 93) practice deliberate deformation, esteeming a flat forehead as a mark of beauty. In the course of the process, the occipital is flattened as well.

The situation from Burma, across northern India, to Afghanistan, is not as yet well known. There is some intentional deformation here (Dingwall, 1931: 86 ff.). Dr. Gordon Bowles, who is preparing a monumental work on this

part of the world, is not prepared to furnish a detailed report on the cephalic index of the area, nor is he satisfied with the total of information on customs relative to deformation to date. He does say (personal communication) that the Karens are hyperbrachycephalic and have deformation practices.

(8) Hainan. Harrower (1928: 251) gives the cranial index of 39 Hylam Chinese skulls from Hainan as 87.89; his photographs show a typical deformed skull of the type we became accustomed to among the Maronites. He reports that the infant is tied to its mother's back in a wicker cradle, in which it may remain the greater part of the day; but the data are not complete enough for my purposes. The presumption of occipital flattening due to cradling is very strong, however.

(9) China, Manchuria, Korea. The picture here, as one should expect in such a large area, is complex; but certain correlations of cradling and high cephalic index seem to emerge. Lasker (1945: 314) states that occipital flattening apparently associated with cradling practices occurs in Manchuria and in East China (especially Anhui), but not in South China (except for the Island of Hainan, as we already know). He remarks that most of the Chinese have rounded occiputs (a fact not in itself negating all external mechanical influence on the area), but that various authors (pp. 279–80) mention occipital flattening, especially from the parts of China just mentioned. Dingwall (1931: 99) is clear about deformation among the Manchus, and that agrees perfectly with the hyperbrachycephaly observed (although on a number less than 100). Lasker (1945: 281) specifically mentions that the bulk of the Chinese turn their infants from side to side in their little beds; whereas the people of northern China put a cushion of rice grain under the infant's head and lay it with the back of the head on this comparatively hard pillow. The Koreans are said to have received the custom of pressing the head with flat stones from the people that fled from Honan and Shansi (Dingwall, 1931: 98); the Manchus may have had their ancestral home in the northern part of Korea (p. 99), so I may well presume that the Koreans have some effective form of cradling, even though I cannot at the moment document this statement.

Before going on to groups of people to which the Manchus would naturally lead us, I should like to remark on the state of affairs in several islands in the Pacific.

Hawaii is one of the far-flung exceptions to the fact that hyperbrachycephaly chiefly occurs in a couple of major areas on the map. Here we find that the head of the infant is often placed in the hard shell of a gourd, and adults continue the practice of lying on a hard surface when sleeping. Porter (1889: 232) quotes an old author who thinks that the custom the Hawaiian mothers have of supporting the backs of the heads of their infants with their left hands induces flattening. We may well regard this reasoning with suspicion. As Porter adds, mat pillows and blocks of wood are probably more likely causes of the flattening. Ploss (1884, II: 56) remarks that the Hawaiian mothers do not carry their babies much, but leave them swaddled and lying on a mat most of the day.

On Samoa (Dingwall, 1931: 147–48) stones are employed for flattening the occiput. Tahitians (p. 149; Porter, 1889: 233) have flattened occipital regions, and earnest massage, in addition to hard pillows, is employed there. The process of artificial deformation seems to have been widespread among the Polynesians (p. 232).

(10) Central Asia. Returning to Asia, our most interesting area, we come to a group of peoples whose form of cradle (transmuted by cultural adaptation) became that of the Maronites, and whose cradling practices have just as clear an effect, if for the most part a lesser one, on the head form as do those of the sedentary group we used for our experiment. This lesser effect, reflected in cephalic indices for the majority of less than the Maronites' 88, is due partly to variations in the ideal pattern of cradling, partly to the very nomadism of the peoples involved — the infant is carried about more and the cradling is not so serenely done as among the sedentary Maronites.

In this area, we must distinguish forms of cradles typical of it, as opposed to those in favor in near-by regions. The typical north Asiatic cradle type is the "Muldenform" (the tray-shaped cradle) (Pflug, 1923: 189) made of wood, equipped with thongs attached to its sides for use in fastening the infant securely to

its "bed." This type, unless certain variant adaptations are introduced, is admirably fitted for producing planoccipital hyperbrachycephaly. One such variant is the cutting out of the portion of the wood upon which the infant's head would rest, so that only skins are left for the support of the tender head. "Dadurch," says Pflug (p. 190), "vermeidet man die Abflachung des kindlichen Schädels." As a general rule the use of the cradle fades out the farther north we go in Asia; possibly for the same reason that the Eskimo infant is warmer and better protected inside the upper garment of its mother, and the Kamchatka baby in the similar arrangement that is used on that peninsula (Ploss, 1884, II: 83), or possibly because of cultural choice.

The central Asiatic form of the cradle is the "Kastenwiege" (the box cradle) (Pflug, 1923: 192), which becomes, after the adoption of the custom by sedentary peoples, the "Kufenwiege," the rocking cradle (p. 192). The central Asiatic form, often equipped with a mechanism for leading off excrementa, is spread all over the Near East, throughout the Caucasus, and is widely distributed in western central Asia (Ploss, 1884, II: 107 ff.). In this cradle, the infant is firmly bound and left immobile for long periods of time — a process guaranteed to include planoccipital hyperbrachycephaly in the subject. This effect will be the greater the more the cradle is kept horizontal.

The box cradle fits in admirably with the nomadic life of the peoples of central Asia; and details of form, such as the tying in of the baby, make sense when related to nomadic life, rather than to the sedentary, as is obvious.

The documentation for cradling in this central Asiatic region is not a difficult project. The areas, both of hyperbrachycephaly and cradling would be more continuous on the map, except for my restriction of the indication of the cephalic index to that drawn from groups measured in numbers of one hundred or more, and except for a few minor gaps in our knowledge of customs. But the continuous nature of the area as a whole is absolutely undeniable, and presents us with an exemplary area of the diffusion of a custom.

To begin with the far eastern end of the area, we find the Gilyaks a perfect case in point for our discussion. They have the type of cradling we have been describing (Pflug, 1923: 189), and they have had it for some time, at least (Pérouse, 1799, III: 244–45); they also possess a high cephalic index; and Gerhardt's (1937–38: 411) description of a typical Gilyak skull is exactly one that would apply to the Maronite type of cradled skull.

Gerhardt (1937–38: 412) attributes many of the elements of this description to the heads of the Aleutians, too; but the situation there is not as clear as I should like it to be. These people have a high index (84); but the fact that Hrdlička (1945: 510) denies any more than rare occipital flattening to them puzzled me for a while. The Aleutian skulls that I have been able to examine are quite a varied lot: a few may have suffered deformation from bands tied around the head; some have small lambdoidal flattening; still others are broad and rounded posteriorly. It seems probable to me that the skin (or woven grass) cradles illustrated by Hrdlička (pp. 64, 425–26), often equipped with moss in lieu of a pillow, may produce a shorter but rounded head; it is even clearer to me that infant treatment must be quite variable in this area.

Pflug (1923: 189–92; compare Ploss, 1884, II: *passim*) predicates cradling not only of the Gilyaks, but of the Golden, the Orochee, the Buriats, the Tungus, the Kalmucks, the Mongols, the Kirghiz, and various Turkish-speaking central and south-central Asiatic peoples. Murdock (1934: 155) attributes cradling to the Kazaks, and describes the characteristic method of leading off the excreta by means of a tube. This technique is a criterion especially of the cradling practice of the peoples of the western part of the area we are now considering; we have mentioned it in connection with Maronite cradling. Slight variations, of course, occur throughout Asia. Thus, Seebohm (1882: 62–63) tells us of the softening material (sawdust) placed in the oval bottom of the Ostiak cradle of his day.

Field (1948) offers us new and interesting data on the head forms of Asiatic peoples. The Tajiks (p. 146) have an index of 83.5, and occipital deformation (usually asymmetrical) is reported in 69 per cent of the subjects studied. The Kirghiz (p. 188) are categorized according to occipital form thus: flat, 44.4 per cent; round, 37.9 per cent; prominent, 10.3

per cent; indeterminate, 7.8 per cent. The occipital form of the Kazaks, Tuvans, and Buriats are characterized in general as "flattened-rounded" (p. 192). Nineteen skulls of the Orochees of the maritime area were discovered to possess flattened occiputs. A very interesting point is the information concerning the custom of the Turkomans; at first these people seem to present us with a difficulty, since they yet are dolichocephalic (p. 165), but we are subsequently informed that they practice intentional deformation designed to produce that dolichocephaly (p. 178).

The possibility of a consoling corroboration of our thesis is afforded by the Hazara, whose hyperbrachycephalic index stands out incongruously amid the longer heads of Afghanistan. This little group, however, is really derived from central Asia (Hunter, 1885: 43–44; Jarring, 1939: 78–81; Field, 1939: 61, 93, 138, 252), from whence they may well be presumed to have brought with them cradling customs in keeping with the area of their origin.

The scattered brachycephals of Iran present a situation difficult of analysis. There has been some diffusion into the area of the central Asiatic form of cradle, but infant treatment is quite haphazard in this region (Ploss, 1884, II: 34, 57, 109) — a sad fact that more than once blurs the edges of our map and of our knowledge.

(11) The Near East. Pflug (1923: 193) simply makes the general statement that the central Asiatic form of cradle and cradling is spread from the Caucasus to the shores of the Mediterranean without notable change; and this seems to be true. He also points out that there is no evidence that the peoples of the old Iranian, Armenian, or Babylonian cultures ever employed such cradles. That modern Armenians have them is well known (Chantre, 1895; Virchow, 1924; Coon, 1939: 626; for a variant method, see Ploss, 1884, II: 97), as is also the fact that this cradling has at least some influence on the shape of the head. I believe my experiment has demonstrated how much and how important that change can be. Besides our Maronites and the Armenians, other hyperbrachycephalic peoples possess this cradle: some of the Kurds, the Bakhtiaris, the Nosarīyeh, the Druzes, and the Metwalis (Dingwall, 1931: 84; and my personal observation of the last three groups mentioned). Chantre (1891: 17) says that the Chaldaeans (or Aïssores) have the same deformation as the Nosarīyeh and the Kurds, without mentioning the cradle. In view of the facts I have been presenting, I prefer to believe that some of the Kurds, now living in close contact with the cradling Armenians and therefore open to the reception of the custom, have adopted cradling and so become "deformed," rather than that they left the plains of Mesopotamia only six hundred years ago as a long-headed group and became hyperbrachycephalic simply by mixture with the mountain people, who are themselves "deformed" (Coon, 1939: 630).

Such cradling is certainly not an Arab custom, although Pflug (1923: 193) mentions having seen some well-to-do Arab families that have adopted it. In his Syrian study Seltzer (1936: 46) mentions that the center of greatest occipital protrusion may be found in the Damascus district (in the contact-zone between mountain Syrian and desert Arab regions, the "desert-border region"), and that that character becomes less pronounced as one progresses northwestward towards the land of the Alawiya. The Bedawins of the desert, of course, are dolichocephalic gracile Mediterraneans (Coon, 1939: 623). It is, therefore, with frustrated curiosity that I mention a small outlier of hyperbrachycephaly in the Hadramaut region, in southern Arabia. The types discussed by Keith and Krogman in Thomas (1932: 301–33) are obviously "cradled" heads; but I can find no information regarding infant treatment in this region. The same may be said of the few "Dinarics," with flattened occiputs, found in the Yemen (Cipriani, 1938: 134, 149).

The Caucasus is not only included in the distribution-area of the central Asiatic cradle form, but includes also manifestations of intentional artificial deformation (Chantre, 1881–82; Dingwall, 1931: 68–69, 71–72). The Caucasus is a very complicated portion of the anthropological map (as one could guess on first glimpsing a linguistic chart of the area), and cradling is no more uniform throughout the region than is any other characteristic. However, it is common (Pokrowskj, 1900); and one people, the Grusines, are reported to keep the child in the cradle for as long as one and a half to two years after birth.

That the precise custom we are discussing, namely, the central Asiatic mode of cradling, was late in entering the Near Eastern area may

be deduced from a consideration of the various types of skulls unearthed in excavations in the Near East. A useful general review of these, from the point of view of brachycephaly, is given by Sauter (1945), and it would seem that planoccipital hyperbrachycephaly did not manifest itself here until about A.D. 500 (compare Krogman, 1937); that is, as affecting a dominant or large percentage of the populations involved. Perhaps this could be correlated with an invasion of Turkish-speaking peoples, ultimately from central Asia. Perhaps the Maronite bride's "tantūra," so strikingly similar to that worn by central Asiatic women, may add its mite to our evidence of the Asiatic origin of Maronite cradling methods.

Individual hyperbrachycephals appear at least in the third millenium B.C. Perhaps extended and refined information resulting from new researches would cause us to push back the date of the introduction of some method, if not exactly the central Asiatic one, of influencing head form towards hyperbrachycephaly. I strongly suspect that it would be found that some application of external forces which tended to influence the head towards brachycephaly would be discovered to have flourished in the Bronze Age. But here I am speculating, and departing from my proposal to consider only modern peoples in this study.

(12) **The Balkans.** Leaving Asia, we now cross over into Europe. This continent was already equipped with its own forms of cradle, before the introduction of Asiatic forms. Pflug (1923: 201, 203) speaks of the "Trogwiege" (the trough cradle) and the "Korbwiege" (wicker or basket cradle) as European, in opposition to Asiatic, forms. He believes, and the fact seems to be, that the "Kufenwiege" (rocking cradle) came into Europe together with an influx of Turkish-speaking peoples. It is certain that such peoples had the Asiatic form of cradle at least by the fifth century A.D., and Pflug (p. 209) selects the Huns as one of the peoples responsible for its introduction into Europe.

The European cradle was never distinguished by methods of fastening the infant into position in it. It was (and still is) very often simply a sort of little hanging bed for the baby; even where the rocking cradle is popular, the baby's relative immobilization in the cradle is accomplished rather by tucked-in covers than by firm swaddling, and never by thongs or bands, with rare exceptions today (directly traceable to Asiatic influence).

Pflug (1923: 201–05) and Dingwall (1931: 16–78) describe the various cradles of modern Europe, and artificial deformation practised in various sections of the continent.

Crete, as well as Anatolia, shows the effect of the practice of deformation, as well as cradling (Dingwall, 1931: 74). The distribution of both in Greece is spotty. There are local remains of the custom of binding the head of the infant with cloths (p. 73). The average Greek of today is brachycephalic, but not highly so (Morant, 1928: 367), but there are exceptions, in western Macedonia and in the Peloponnesus. It was in Macedonia that Hasluck (1947: 130) came on the custom of present-day head-bandaging (it is of considerable antiquity here and in allied areas [Ploss, 1884, I: 322]), which in this case produced a backward-sloping forehead and a flattened occiput; she also heard of the same sort of custom being practised in the Peloponnesus, by the Vlachs in eastern Macedonia, and by the Turks of Konia. She carefully abstracted the records of any Macedonian heads which seemed to show the slightest deformity. "Even so," she writes, "I have never felt that the records of apparently normal heads which were published by Hasluck and Morant in the paper 'Measurements of Macedonian Men' in *Biometrika*, 1929, pp. 322–36, were fully to be trusted."

In ancient Greece, and indeed in much of the Mediterranean world, the cradles were of two principal types. The *λίκνον* of the Homeric age was a flat swing of basket-work (Porter, 1889: 227–28); there was also a shoe-shaped cradle, in which the child sat up. The infant is wrapped in swaddling clothes (*σπάργανα*) (except in Sparta) concerning which Dingwall (1931: 76) says: "With regard to the swaddling clothes used by the Greeks, it does not seem that these were usually very tight; rather they served for protection against the injuries of childhood." At any rate, the swinging cradle, the shoe-shaped cradle, and other types in which the child sat seemed to have had little effect on the occiput by way of noticeable flattening.

In Bosnia, Albania (Haberlandt, 1917: 182; Nopcsa, 1925: 228), and Bulgaria (Pflug, 1923: 202; Dingwall, 1931: 73) cradling and the

"Dinaric" head form are clearly and causally connected. This subject will be exhaustively investigated for these areas in the forthcoming publications of Professor C. S. Coon and Dr. R. W. Ehrich. Bosnia and Herzegovina are also areas in which a certain amount of head-bandaging takes place (Dingwall, 1931: 73). One of our many and complicating variables shows its head here, too; at least in 1884, Ploss (1884, II: 36) tells us that the richer people did not bind down the infant into the cradle, whereas the poorer ones did.

(13) Central Europe. Actually, our knowledge of cradling customs among individual groups is definitely better for more out-of-the-way folk than it is for many parts of the population of civilized Europe. In addition to the fact of lamentable lacunæ in our preserved information, continuous change makes much of the pattern of European custom fairly fluid.

However, I should like to interject two general remarks at this point. The first: it would be strange if we could drive our correlation of cradling and hyperbrachycephaly right up to central Europe, and then find that purely racial factors took the reins in hand completely. More especially, it would be strange if this happened in a section of Europe particularly affected by the inroads of central Asiatic peoples. The second: it would be strange if, after all the generations of racial analysis practised in Europe, the racial element did not have some effect. I am, therefore, not denying the racial differential here, or elsewhere; any more than I am denying the pathological differential. The most I want to say about Europe specifically (but I shall generalize the statement later) is that this factor of the postnatal treatment of infants according to cultural patterns should be taken into consideration when evaluating the cephalic index.

It is, in fact, only possible to make general remarks about Europe. A great deal of detailed study in various localities would have to be made before anything better could be done. But here and there a ray of light, a definitely focussed ray, does penetrate the gloom of ignorance.

However, general remarks can also be somewhat enlightening. For instance, if one compares the central European section of our hyperbrachycephaly map (fig. 7) with the one on which Dingwall (1931: opp. p. 16) gives the locations of ancient (i.e., mediæval times on) skulls which show clear evidence of artificial cranial deformation, one notes immediately that they largely coincide, if we add France (a country I shall consider in the next section but one). Now, cradling and intentional cranial deformation are often intimately allied. As Delisle (1902: 124) says: "De ficeler le corps à ficeler la tête il n'y a qu'un pas." And Pflug (1923: 211) is certain that the practice of deformation and the cradle came hand in hand into North, Central, and South America.

The deformations found on skulls in Germany, Austria, Hungary, and near-by regions (Dingwall, 1931: 24–28) show compression of the forehead, as if by means of a board applied to that part. This sort of thing is quite often found elsewhere in connection with the cradling of the child, for example among the Chinook. Some of this may have been practised only among aristocratic families, as Dingwall (pp. 29–30) suggests, and deformation very often has a social differential; the point is that new concepts about the care and treatment of infants' heads had come into Europe. The Huns seem certainly to have indulged in head deformation, to the point of producing a horrific "sugar-loaf" form of head (Dingwall (p. 31); Pflug (1923: 209–10) is convinced that the Huns brought the central Asiatic form of cradle into Europe, as we have already seen.

The European types of cradle we have mentioned — the trough and the basket cradles (Pflug, 1923: 202) — flourished over a wide area in ancient Europe. We find some sort of simple cradle among the Romans, the Greeks, the "Old Nordic," the "Old Germanic" cultures, in France in the ninth and tenth centu ries, in Sweden (with the upper classes preferring the hanging cradle, the lower, not), and so on (Pflug, 1923: 201–04). Again I must insist on the fact that the mere word "cradle" does not necessarily and uniquivocally mean that one form of cradle is as effective as another in influencing the head form — for that matter, even the same cradle form can be used by different peoples, or different elements among the same people, with varying degrees of efficiency in this regard. Karutz (1899: 237, note especially fig. 22) points out that the Norwegian cradle was often a piece of sheepskin, in which the bedclothes and the infant were

put, and the whole hung out of the way from a beam in the ceiling. A very different apparatus from the central Asiatic form.

The rocking cradle came on the European scene as a new element, and, after adoption, generally became a massive thing. There was a certain amount of wrapping the infant in swaddling clothes even before this form of cradle came in, for instance in ninth- and tenth-century France, but our previous quotation from Dingwall about the looseness of the Greek swaddling would seem to apply here, since more effective work in this line was done later. Even this early, however, artificial cranial deformation was practised.

Such wrapping has been the custom, in many parts of our area, until very recent times. Boas (1911: 48) cites information to the effect that Bohemians swaddle their children from the shoulders down to the ankles; for the first four to six weeks, the arms also were tied tightly to the body. This swaddling continues for the first five or six months, at least, of the infant's life. The head rests on a pillow of feathers or down. This information, added to further information I shall present from the literature of experimental work in Chapter IV, goes far towards suggesting that a large factor, to say the least, in Bohemian round-headedness is infant treatment.

Boas (1911: 49) also adduces information from Dr. M. Fishberg to the effect that the people of eastern Europe, both Slavs and Jews, swathe their infants from the shoulders to the ankles. They lay their infants on their backs in cradles, with their heads resting on pillows. The process continues for at least three months, often as long as six, or even longer, if the infant's vitality be poor. That last element, combined with what we shall learn about the effect of craniotabes from the medical literature in Chapter IV, indicates that here we have the possibility of at least some of the hyperbrachycephals of eastern Europe being strongly influenced by infant treatment. Information elicited from Bohemians, Moravians, and Germans from certain parts of Germany, gives the same picture. Some of the information in the literature is tantalizing. Ried (1930) in his study of the Miesmach population, in southern Germany, casually mentions on page 152, that presents for the newborn baby are inserted in among the "Windeln" — how tightly the baby is swaddled, for how long, on what kind of a mattress or other support he lies, is he ever turned in bed — numerous important elements remain undocumented.

No doubt it can still be said of the conservative Germans, what Vesalius remarked so long ago: "*Germani ferè breve caput obtinent, quod dorso semper in cunis incumbant.*" "The Germans commonly have short heads, because they always lie on their backs in their cradles" (Dingwall, 1931: 19). Perhaps a writer of today could not state, as does Ploss (1884, II: 38): "Kaum in irgend einem Lande wird das Kind so unzweckmässig eingehüllt, als noch jetzt bei uns in Deutschland." But the lingering influence of such a pattern must still be felt, especially in rural districts; many of the subjects, whose head measurements are registered in the literature, were bedded as infants under the old regime. Ploss (II: p. 38) goes on to describe (e.g., in Bavaria and Frankenwald) the complicated swaddling, done so that the infant will grow up straight (the reason given by the Maronites); in another place (II: 113) he tells how the infant is fastened into the cradle in Württemberg; and in still another (I: 326), how the Swiss midwives strive to give their charges round heads.

Along with the cradling situation, we have in central Europe the complication of intentional deformation: Dingwall (1931: 689) predicates such practices of the Poles, and (p. 65) of the Hungarians.

It is clear that on our map we are using the mean cephalic index of an area of a people, but we are not being completely taken in by this procedure. Even within average dolicho- or mesocephalic groups one finds a greater or lesser percentage of brachys and even hyperbrachys. Even in experiments carried on with numerous infants as subjects (such as we shall see in Chapter IV), the process of affecting the head shape by mechanical means is only successful with a percentage. Whether this be due to inherent racial and individual heredity or not, the converse is true: the presence of a certain number of hyperbrachycephalics could well be due to infant treatment. Or, better put perhaps, to racial *and* cultural and mechanical factors together.

We note from Pflug (1923: 202–04) the presence of the European types of cradles, and also of the rocking cradle ("Kufenwiege"), in

Sweden, England, Holland, Spain, Denmark, and Norway. This type of cradle is by no means so well adapted to the conditioning of the infant to hyperbrachycephaly as the central Asiatic original type. Still, we note from Gerhardt (1937–38: 286) that the low brachycephalic Danes show a percentage of 63 per cent cephalic indices 81–x. The Norwegians (omitting the three northern provinces) have up to 42 per cent 81–x (p. 284). The Finns, who employ a hanging cradle and also a shoe-shaped cradle which is carried on the mother's back and in which the infant is fastened and spends most of its time for the first year (Buschan, 1926: 950, 955), have 76.5 per cent 80–x indices, and 67.8 per cent 81–x (Gerhardt, 1937–38: 287). I do not have to insist on this point, since 80 or 81 and over in the proportion of 70 per cent of the population proves that there are a great many high brachycephals and hyperbrachycephals present in the population in question.

(14) **Russia, Lappland.** Russia is characterized by a general brachycephaly (Tschepourkowsky, 1922, by Provinces; Gerhardt, 1937–38), which increases in index towards the south, and is 83 from the Carpathians southward and toward central Europe (Tschepourkowsky, 1911; Gerhardt, 1937–38). A great deal of intentional deformation has been practised here (Dingwall, 1931: 33 ff.), and pads and compresses have been employed at least until very recent times (pp. 68–69), if not up to the present. The various forms of cradle mentioned are also in use in this territory. Ploss (1884, II: 36) tells us that in his time the Russians in Astrakan were strict about swaddling the infant and keeping it motionless in the cradle; in the district of Samara, however, the baby was now overwhelmed with clothes, now left naked on the floor.

A very interesting and clear-cut case in point for our study is afforded by the Lapps. They practise molding and bandaging of the head, they employ head-dresses that constrict the head, and they have the cradle, of an effective type (Hatt, 1915). The description of the typical Lapp skull that Gerhardt (1937–38: 407) derives from various authors sounds very familiar, especially in the last phrase: "In der Norma lateralis steigt die Stirn bei der genannten schwachen Glabellarentwicklung steil oder ganz wenig geneigt bis etwa zum Metopion auf, verläuft dann mit schwacher Steigung in deutlich flachem, aber kurvigem Zuge nach hinten über das Bregma bis zum Vertex hinauf, *um von hier mehr oder minder steil zum Lambda abzufallen, in dessen Bereich die Mediansagittalkurve sehr oft eine — häufig recht starke — Abflachung aufweist.*" (Italics are mine.)

Karutz (1899) gives an illustration of the Lapp cradle, and Hatt (1915: fig. 40) a photograph of a Lapp women exhibiting the "hinged" flattening — and the connection between the two is plain. Turi (1931: 36–37) gives a first-hand account of the intensive cradling of the Lapp child; an account which might do, in its essentials, for that of any nomadic cradling people, from central Asia to Patagonia. Hatt (1915: 255) has a wistful sentence, that I may well echo, thirty-two years later: "As the practices connected with the bringing up of infants are rather apt to escape observation, this side of the life of primitive tribes is by no means as thoroughly known as it ought to be."

(15) **France, Italy.** Before finishing with Europe, and retracing our steps so as to follow the other arm of the diffusion of the Asiatic cradle and its sequelæ which extends to the Americas, we must discuss the situation in France and Italy.

France is the "classical" country for artificial cranial deformation in modern times (Dingwall, 1931: 19), and numerous examples of such practices in fairly ancient times are known (pp. 46–62). The highest modern cephalic indices are still recognized in the region of the central plateau of France, which I am assured is an intensely conservative area, in fact practically marginal in some respects. Lapouge (1897) reports various high indices, from 90 to 100, from this area, blandly ignoring the possibility of deformation. On the southern extension of this plateau, Delisle (1902: 144–46) describes the swaddling of babies and the binding down of the infants' heads themselves in the cradle. Collignon (1887: 309) is puzzled by the presence of high brachycephals in the mountainous areas of northeastern France, in spite of the fact that the stature of these short-heads is great. In the normal course of events, the greater the stature, the greater the head length. Gueniot (cited in Dingwall, 1931: 55–

56) tells us of a particularly decisive local method of swaddling the infant and tying down the head with a triangular piece of linen. There are, then, in France, effective methods both of lengthening and shortening the head, the first being mostly the use of circular bandages from forehead to sub-occiput, and the latter connected with cradling. No picture of the status of the cephalic index in France could do well to ignore these culturally patterned interferences with nature. And it is high time that France were studied all over again. Apart from such improvements in our knowledge as the application of the newer techniques would make possible, one might anticipate a change in the cephalic index map. I should not be surprised if changing custom had not brought about a fall in the index particularly in certain areas, a fall which would be more marked and conclusive than that recently noted in Switzerland (Schlaginhaufen, 1946; Sauter, 1946: 147).

The cephalic index map of France (Gerhardt, 1937–38: 397) shows many interesting variations in this criterion. I do not know exactly what customs are practised along the semicircle of high indices that covers France's northeastern borders. I do know that many a person, who belongs to Broca's old (1873) "*type celtique*," does so at least in central France, and probably elsewhere, because his mother induced the "Celtic" hyperbrachycephaly after he was born.

Notice of the Savoyards on the map leads us to a consideration of the peoples on Italian territory. The Savoyards themselves, big-headed and short-headed, are connected with a hyperbrachycephalic central European area, and so are the northern Italians. The Tirolese, whether German or Italian, are notoriously short-headed. And so are many Swiss. I shall reserve some interesting remarks about the Swiss (which may be applied also to the Tirolese) until I cite the literature on the problem of brachycephalization, especially of central Europe, in Chapter IV.

As regards Italy, Gerhardt (1937–38: 319–20) reports no less than 27 provinces that show 90 per cent of 80–x indices. Other figures are as impressive. In a general way, this brachycephaly is strongest in the north of Italy, and shades off into longer-headedness as the "ankle" and "heel" of the "boot" are reached. The province of Naples, however, possesses a percentage of 80–x indices as high as 80.9. Boas (1911: 49) states that Neapolitans and Sicilians swathe their infants, and that swaddling continues until the infant is weaned. During the summer, however, children are freer than during the winter. That is the sort of qualification that is forever entering the reports, leaving a distressful uncertainty behind it.

A few specimens of ancient skulls showing deformations have been discovered in Italy (Dingwall, 1931: 28–29) but they are not so numerous as elsewhere in Europe. Dingwall (p. 62) also reports some molding as being practised in this country. Just how much, or how intensively, or how long it is practised, I do not know.

(16) **The Americas.** The main areas which are or were characterized by intensive and intentional artificial cranial deformation in the Americas have been indicated by horizontal hatching on the world map (following Imbelloni, 1934–35: tafel 18). In general, the incidence of this practice coincided with the western mountain backbone of the two continents, overflowing occasionally. This overflowing was notable in the southeast of the United States, where, however, the cradleboard became pre-eminent among deforming methods, and only occasional examples of other mechanical devices are found (Dingwall, 1931: 183–89). Intentional deformation also followed around the curve of the West Indian Islands.

The "Mound Builders" and other pre-Columbian Indians left skulls which show evidence of deformation (e.g., Hooton, 1920; Webb and Snow, 1945). In studying the Madisonville skulls (Hooton, 1920) and later in his much larger work on the Pecos skulls (Hooton, 1930), Hooton shows how much the cranial index may be changed by simple occipital flattening. In fact, his was the first important craniological study of which I am aware that recognized the problem and attempted to determine the normal status of the population in question by juxtaposing deformed and undeformed skulls.

The use of some sort of cradle, however, is more widespread by far than is the practice of intentional artificial cranial deformation. The chief varieties of cradles, beginning with the North, are (Pflug, 1923: 194–200): the

"Rindenwiege" (bark cradle) among the Indians of inner Alaska and along the Mackenzie River; the "Trogwiege" (trough-shaped or dugout cradle) in the case of the Northwest Coast Indians; the "Korbwiege" (basketry or wicker cradle), confined to the western part of North America; the "Brettwiege" (cradleboard), the simplest and most widespread form from the Northwest Coast throughout the central continent and down to Mexico; the "Hurdenwiege" (the slat or fence-like cradle) of such people as the Ute, the Yuma, and the Cliff-Dwellers; the "Lattenwiege" (ladder cradle) of many Plains tribes, such as the Comanche, the Kiowa, and the Sioux. All of these types, and innumerable intermediate forms, occasionally concomitant with intentional deformation, are found in North America. They are all varieties of the fundamental "cradleboard" — a device for securing the infant to a flat surface, thus rendering it relatively immobile and a handy unit package. It is interesting, as Ploss (1884, II: 81) remarks, that only among aboriginal Americans is the infant carried with its back to that of its mother.

The general picture in South America is similar to that found in its northern counterpart — a distribution down the mountains of the west, spilling over at times into the bulk of the continent; in this case the overflow takes place in the north and in Patagonia. The famous Aymara deformation on the Andean heights is familiar; almost as well known is the occipital flattening of many Patagonians, who employ woven cradles (Pflug, 1923: 196) and forms of the "Brettwiege" (cradleboard) (Virchow, 1879: 200).

Africa is, in fact, the only continent without cradles. Pleasantly enough for our thesis, it is also a continent of unrelieved dolichocephaly (some of it encouraged by intentional deformation), except for a low brachy area inside the western bend of the continent, and a tiny hyperbrachycephalic area around Lake Chad; in all three exceptions deformation is proven or suspected (Dingwall, 1931: 102 ff.). The little, somewhat dubious spot indicated on Madagascar (see map, fig. 5), is easily explained by the local custom of fronto-occipital deformation (pp. 119–20).

Coming back to the Americas, I shall now go somewhat more into detail concerning the cradling customs that flourish there.

Some Eskimos are no doubt affected in head form by hard pillows or head rests (Mason, 1889: 166), but on the whole the infant Eskimo is plumped into the back of the mother's upper garment, and so escapes much-continued pressure on certain areas of the head. Hrdlička (1924: 50) gives the cranial index of some 61 "Alaskans and Athapascans" as 82.1 for males; 48 females have an average cephalic index of 83.4, so I may well assume that the "Rindenwiege" (bark cradle) mentioned by Pflug has some effect. Among the "Tinne or Chippewyan," Mason (1889: 166) reports the custom of fashioning the "cradle" so that the infant sits on a soft fur seat. Sitting cradles are not usually effective in producing shortening of the head.

The Chinooks and the Nootka (and other neighboring peoples) employed a "dugout" cradle (Pflug, 1923: 194), and an apparatus for deformation the results of which no one could mistake (Dingwall, 1931: 164 ff.). One might develop the speculation on the possibility of flattening being first an accidental effect of cradling, then coming to be regarded for some reason as desirable, and finally being fostered and improved on. We are not deploying into the field of ethnology in this study any more than we have to for our essential purposes. However, I must again call attention to the fact that social differences are important to our study. The average cephalic index of a tribe will be quite different if only the aristocrats, the descendants of the conquering group, employ the cradle — or if everyone uses it. The gradual disintegration of the pattern or patterns connected with cradling would also apply to our study. In fact, one very great difficulty (unsolved at the moment, because of the disproportionate amount of labor involved) in my consideration of America is the fact that I am not always able to pin down a definite custom to a definite cephalic index at a definite time. Is my record of cradling for a tribe synchronous with the record of the cephalic index, as recorded in the original study or in such compendia as Steggerda (1932) or von Bonin and Morant (1938)?

The Modoc (Dingwall, 1931: 182) show an interesting mixture of methods: bandages around the head being favored by some, fronto-occipital methods of deformation by others; some use the sitting-type cradle, others the

board type, which latter seems to have been designed to stand against a wall, or somehow set up vertically (Mason, 1889: 179).

The "Korbwiege" (wicker cradle) is found only in the western part of North America (Pflug, 1923: 195); such people as the Salish and the Thompson Indians have it; the Hupa and the Shasta have the slipper-shaped or chair cradle. The simplest and most widespread form of cradle spreads out towards the east: the "Brettwiege" (cradleboard) (p. 197). The Chippewa, for example, the Blackfeet, the Sioux, the Crow, the Algonquins, the Iroquois, the Ute, and many other tribes use either a simple or derived form of the cradleboard.

One great difference in effectiveness for cranial deformation between this form of cradle and the "Kastenwiege" (box cradle) of central Asia or the "Kufenwiege" (rocking cradle) of the sedentary folk is the fact that the box cradle is intended to be and normally is held horizontally. The weight of the relatively immobilized head against the "pillow," therefore, is a powerful factor in producing occipital flattening and hyperbrachycephaly. The cradleboard, on the other hand, is intended to be and quite usually is carried upright, either on the mother's back, on some other form of transport, or stood upright against a tree, hung upright from a bough, or otherwise disposed, but upright for all of that. The effect on the shape of the head, no matter how firmly the infant is fastened to the board, is quite other than among the users of the central Asiatic form or its derivatives.

So, for instance, among the Iroquois, the mother carries the cradle by a tumpline, and often hangs it on the branch of a tree (Murdock, 1934: 311), and in addition all Algonquin and Iroquois cradles have a footboard, to support the infant from below and take the weight off the fastenings (Mason, 1889: 204). The Aztec mothers carried their infants in wicker cradles on their backs (Murdock, 1934: 383). The Chippewa, Blackfeet, Sioux (for these there is a footrest, and the arms of the infant are usually free, except on journeys), the Ute, all carry the child vertically (Mason, 1889: 168, 188, 201), and in general Mason (p. 193) remarks that there was plenty of free play to the infant's head. Now, I am in no position to state just how much effect this method has on the infant's head. Are all the Indians with indices of 79, or even somewhat higher, listed by Steggerda (1932), absolutely untouched by this process; or would their indices have been even lower, without such cradling? I am inclined to think that these heads are fairly normal in cephalic index. Again, different tribes have changed their customs in this respect. Catlin (1841, II: 112) already noticed diminution in deformation customs among the Indians he visited in the dawn of the last quarter of the last century. And certainly the successive generations of Indians in the southeastern part of the United States were no more uniform temporally than spatially in deformation.

A difference in use of quite similar cradles was acutely noticed by Hrdlička (1908). He was clearly conscious of the fact that immobilization of the infant on a pillow could produce occipital flattening (Hrdlička, 1947: 49); and the difference ties in with great differences in the cephalic index. Hrdlička (1908: 79) remarks that tribes such as the Ute, Jicarilla, Pima, Papago, Walapai, Havasupai, and most Mexican tribes he investigated, use the cradle, but in such a way as to leave the head normal in shape. On the other hand, the Apache, Navaho, all the Pueblos, and the Yuma limit the motion of the infant's head and thus induce occipital flattening.

However, Hrdlička unfortunately did not distinguish between "straight" occipital flattening and "hinged" flattening, and he did not note the fact that "hinged" flattening can very easily pass over into lambdoido-occipital flattening, which in turn can easily merge with lambdoidal flattening. All of these flattenings are caused by external pressure during infancy. I speak here of lambdoidal flattening when it is recognizable precisely as caused by deformation; I do not wish at this point to say that all simple lambdoidal flattening is caused by mechanical external forces. At any rate, I am not sure that all of Hrdlička's "normal" heads really were such.

A large amount of the lambdoidal flattening I have seen on Indian skulls is, I am convinced, caused by external forces, and this is perfectly clear in cases of what Hooton (1930: 37) calls "lambdoid deformation," which is, as described, smaller in area than what Stewart (1940: 154) calls "lambdoid deformity." One of the reasons I feel there is a large chance for imperfect correction in Shapiro's (1928)

formula for the correction of deformed heads is the very fact that the plane of the flattening can "swing" on its "hinge," as well as change in area, and will affect the metrical picture variously as it changes.

At any rate, the slanting, fairly high, often small flattening, which we can call "lambdoidal" or "lambdoido-occipital" (according to the noninvasion or invasion of the occipital region) may have two kinds of possible explanation in external forces operating during early infancy. The first is the build of the cradle. Imbelloni (1934–35: 175) makes an illuminating remark in this respect. He refers to the practice among many tribes, such as the Ute, the Apache, the Ojibway, of placing the baby in a cradle which is turned up in one way or another at the head end. Mason (1889: 178) gives an illustration of a Hupa curved-back cradle which turns up at the head end. When the baby lies (or half stands) in such a cradle, his head is not lying back naturally, but the vertical axis of the head forms an angle with that of the body, and the baby's chin approximates (sometimes closely) the anterior uppermost chest region. In this case, says Imbelloni, "Der Schädelteil, der abgeplattet wird, ist rein lambdisch." I have noted lambdoidal flattening on Californian Indian skulls which could very well have been so caused.

The second method of producing high, "hinged" flattening — a method conducive to flattening over a wide area of the posterior part of the skull — is that of placing a neck pad or a pillow under the shoulders and neck of the infant. This is done, for instance, by the Hopi (Dennis, 1940: 31), and it is interesting that they allege the same reason for the practice as the Maronites, namely to prevent the child from growing up short-necked. The Hopi also carry the cradle horizontally. The combination of these two factors is guaranteed to produce a large "hinged" flattening. Some time ago I referred to a comparison between the profile of the posterior skull among the Alkali Ridge Indians and the first of my Lebanese Maronite photographs (see fig. 4). The combination of a neck-and-shoulder pad and the cradle among these Indians could well have produced that slanting lambdoido-occipital deformation; the Maronite infant is often, as I have indicated in Chapter I, so placed that the pillow is under his neck and shoulders, and the head rests on the mattress or top of the pillow at an angle.

In connection with lambdoidal flattening, it might be interesting to insert here the opinion of Abels (1925) that, if there are any weak spots in a skull with such tendencies, they are as a rule in the portion of the skull where the sagittal suture begins to curve towards lambda. Localized and relatively unimportant pathology could, therefore, add to the picture of lambdoidal flattening.

I have no such exact information about the construction of the cradles of other Indians who used the cradleboard, which would bear on this aspect of cranial deformation, namely, the formation of a "hinged" flattening of some kind. But the possibility must be kept in mind when comparing the cephalic indices of Indians who vary around 79–80 (Martin, 1928: 777; Steggerda, 1932; von Bonin and Morant, 1938) and their customs of cradling. The possibility actually exists of lambdoidal flattening changing the breadth slightly without particularly affecting the length, and also of its increasing the length. One gets the impression from some skulls (e.g., from the Alkali Ridge Indian skulls) that during the course of subsequent head-length growth (described in Chapter IV) the occipital bone pushes itself out in an almost autonomous way, and that the head is even longer than it would have been if not disturbed by artificially induced lambdoidal or lambdoido-occipital flattening. The study of occipital flattening is not complete until a thorough study of lambdoidal flattening appears.

I must remark on an illuminating bit of information from the archæological consideration of "hinged" flattening in the Southwest. While this paper was first being prepared, Brew (1946) published his monograph on Alkali Ridge and (pp. 67–73) discussed the "Pueblo Invasion," basing his remarks chiefly on the study by Seltzer (1944). Seltzer's conclusions, first published in an abstract, were corroborated by Stewart (1940) even before the publication of the 1944 paper. Briefly, the conclusion is that the invasion of brachycephals into the Southwest in ancient times was not the invasion of a new type of people, but of a new custom. Other features than those which would be affected by flattening are practically the same all through early Indian

history in the area, and even down to the present day (Seltzer, 1944). Incidentally, Seltzer's (p. 11) comparison of Old Zunis and Utah Basket-Makers interested me personally, because he obtained the same contrast (although with smaller numerical results) that I found comparing the Lebanese and American Maronites, i.e., large x p.e. for the head length and associated indices.

To get on with our survey of the Americas. Mexico, Central America, and the Islands of the West Indies are notable for intentional cranial deformation (Dingwall, 1931: 151 ff.), but, naturally, not all of the populations involved were equally affected all the time. Hrdlička (1935: 313) gives 79.1 as the mean cephalic index for 46 Aztecs, and it has already been remarked that Aztec mothers carry their infants on their backs.

Other references to deformative and cradling practices for Central America are given by Porter (1889: 221 ff.). I do not think that any more than this cursory attention to this region would be particularly profitable.

The peoples of the various Andean civilizations (Steward, 1946–48) need no new advertisement of their intensive and extensive deformative practices (Dingwall, 1931: 193 ff.). These practices all were accompanied by the use of the cradle (Pflug, 1923: 198). Indeed, one of the difficulties of this study, or, conversely, of a study like Dingwall's, is to keep one form of deformation separated from the other.

The possible relationships of cradling practices and ecology are intriguing. So, for example, Mason (1889: 209) remarks on a general dichotomy in South America: in the tropics the children are carried in a shawl or sash, and bedded in a hammock; in colder regions, the cradle frame appears. In South America, it is true, cradling and deformation follow the mountains, as a rule.

The Incas swaddled their infants tightly and placed them in cradles, from which they were only removed for their morning cold bath. While in the cradle, deforming apparatuses were applied to them (Murdock, 1934: 434–35; Dingwall, 1931: 203 ff.). Running down the mountain chain from north to south, with the exception of a small area in which circular bandages were applied, straight up-and-down boards or pads were used; in the northeast, continuing the line of the West Indies, pads applied at an angle were employed (Imbelloni, 1934–35: tafel 18). How the details of the construction and use of a "cradle" can be of extreme importance in determining its effect is illustrated by a passing remark of Mason (1889: 209) concerning the cradle frame of the Araucanian Indians, which, he says, left the head of the infant perfectly free, except that the lower part of the occiput rested on the topmost crosspiece, "as in the case of the Polynesian pillow." Does this tend to lengthen the head? Or leave it unaffected, since the nuchal musculature of an infant is undeveloped and the occipital protrusion great, relative to its adult status? How long is the infant kept in this situation?

Patagonia is one of the most interesting areas yet mentioned. The cephalic indices are mostly very high (Kate, 1906: 47; Virchow, 1879: 200; Martin, 1896: 533); Virchow comments on the occipital flattening observable, and Martin (1896: 504–05) clearly recognized the skulls as deformed, as did Verneau (1903: 122 ff.) and Dingwall (1931: 222–24). The Tierra de Fuegians, on the other hand (Martin, 1893), are definitely mesocephalic.

The Patagonians use a cradleboard but add a piece of wood on either side of the head of the infant and tie a shawl over this arrangement, in order to protect the child's head while it is being transported on horseback. While this apparatus no doubt represents an adaptation due to the comparatively recent introduction of the horse, the people must have had dorsal decubitus before (Dingwall, 1931: 222). On the occasion of the visit of a Patagonian family to Germany in 1879, Virchow remarks on the possible easy transition between cradling, accompanied by methods of keeping the infant's head from lolling dangerously while being transported, and the gradual introduction of intentional deformation (Virchow, 1879). Cooper (1946a: 120) reports a ladder-type cradle for the Ona, and (1946b: 154) illustrates a wicker cradle with a curved foundation to fit the horse's back, among the Patagonian and Pampean Hunters; while, in contrast, Métraux (1946: 319) says of the neighboring, much more long-headed Chaco folk merely that "Women carry their babies in a sling, straddling the left hip."

With this cursory, and not too satisfactory

survey of the Americas, I bring the study of the correlation of hyperbrachycephaly and cradling (or the equivalent) to a close.

It may be of minor, and ironical, interest to note here that the cradling we have been speaking about, although rather drastic in appearance to American eyes, seems to have no harmful effects on the infant involved (Danziger and Frankl, 1934; Dennis, 1940: 104, 107; Greenacre, 1944; Orlansky, 1949: 21–24). The custom makes a manageable packet of the helpless baby and often induces a change in its head form — a change which is of interest only to a few anthropologists. The head form, however, is of sufficient importance to them that this evidently widespread and efficient cause of its deformation should be taken seriously.

CONCLUSIONS FROM THIS CHAPTER

The ideas garnered from the considerations presented in this chapter may be simply stated.

The direct conclusion from the study of the distributions of hyperbrachycephaly and cradling (or equivalent) is that there is a universal connection between the two. This conclusion, however, because of lacunæ in our knowledge of customs in various small portions of the world, must be characterized as extremely probable — "probable," because we cannot definitively prove it for each and every case; "extremely probable," because of the vast and general sweep of the correlation. Certainly, when we consider this sweep with an anthropological eye, we realize that we have an interesting picture of diffusion; and, equally certainly, when we regard it with the eye of logic, we are well within our inductive premises when we conclude that the factor of infant treatment must be taken into account, and must be accurately assessed, before apodictic statements may be made about the cephalic index or associated phenomena.

THE LITERATURE PERTINENT TO THE EXPERIMENT AND ITS GENERALIZATION

THE purpose of this chapter is to garner from a review of the relevant literature whatever information may be found capable of affecting such clarity or certitude concerning our experiment and its generalization as may have been acquired in the preceding two chapters.

I thought it advisable to present the rather clear-cut results of the comparative anthropometry of the Lebanese and American Maronite series first, then to discuss the generalization achievable by distribution studies, and finally to consider whatever pertinent literature that might be unearthed. The literature, then, is examined in the light of what has gone before; and the irrelevant spared. But this does not mean that I have suppressed any recorded data inimical to my thesis.

Actually, it will be found that in this chapter that the fortunes of the thesis of this study may be characterized by the Vergilian tag, *Vires acquirit eundo.* It seems to me that the cumulative effect of the corroborations and suggestions to be displayed here is of great value; the chapter should be read in its pedestrian entirety, or not at all.

The literature is to be reviewed under the following headings: *The Anthropological; The Embryological and Obstetrical; The Pediatric and Growth; The Medical.*

THE ANTHROPOLOGICAL LITERATURE

Literature on Artificial Cranial Deformation

There has been much written, in anthropological publications, on the various types of mutilations and deformations with which the sundry groups of human beings afflict one or other part of the body (Puccioni, 1904), and particularly the head. Fortunately, Dingwall (1931) has saved us a great deal of trouble by compiling the available sources on the subject of artificial cranial deformation, and I have made liberal use of his book in Chapter III.

For our purposes, two conclusions that can be drawn from this literature are of some importance. The first is the conclusion that the fact that effects of deformation endure is clear. This fact has been well known for a long time. Drastic methods, such as those of the Chinook, produce drastic effects, which persist through later life; less drastic methods, such as cradling, also produce permanent effects; just how little the normal head grows out of early shortening (and how much shortening) will appear from the literature on growth.

The second conclusion is practically no conclusion at all. It concerns the amount of time necessary for the deforming force to work before it produces lasting effects. Something like nine months seems to be the minimum that peoples actually cradle their infants in the central Asiatic way; but is so much time necessary? The more spectacular forms of intentional deformation have been said to be complete after three, five, or eight weeks, as Catlin (1841, II: 111) described it for the Chinooks. Longer times (three months; six months to a year; until the child can walk — Macfie, 1865: 441) have been elsewhere simply recorded as the local custom (Rosa, 1947). In the case of occipital flattening alone, for which relative immobility of the head and gravity and a substance against which the head can press must take the place of the more drastic intentional apparatus, would not a longer time be required than the minimum with apparatus? A digressive question at this point would be that concerning the efficacy of molding the head with the hands — does this not need subsequent recumbency upon a hardish substance for implementation in producing head-shortening or planoccipitaly? There is more than enough room here for accurate observation (not always to be found recorded in ethnographic studies), if not active experimentation. A few simple studies on disparate peoples would settle this simple problem.

The Cephalic Index

I do not feel it would be useful to spend any large space on a consideration of the history or present status of the cephalic index and the divisions thereof. Stewart (1936) has adequately surveyed the history; Hooton (1946: 488 ff.) discusses the index at length, concluding with a much lower opinion of it as an absolute criterion than that worthy percentage has often enjoyed during the long years since its first proposal by Retzius. This study does nothing towards inflating the ego of the cephalic index, particularly as a major diagnostic — the rôle it has been too often called upon to play unaided in the study of races and racial movements.

In view of the several uses we shall make of the paper of Abbie (1947) in our review of literature, it is only right that we should mention his stimulating proposal for a redefinition of mesocephaly. Basing his claim on the mesocephaly of the neonatal head, Abbie (p. 253) claims that a range of cephalic index from 79 to 82 represents the "natural" one for modern man; dolichocephaly under this, and brachycephaly over this, would be aberrations. I should not hesitate, myself, to call every head with a cephalic index over 82 "hyperbrachycephalic" (in the sense of being shortened beyond what is natural, and that almost always by external forces), as a result of the investigations this study presents.

Craniological Studies

Under this heading, we present a sampling of the findings and opinions of craniologists, which have relevance to our main thesis.

Von Lenhossék (1878: 10) experimented with weights on the heads of infant cadavers and discovered that direct pressure from behind on the occipital protrusion presses this bone flat, but affects the other bones of the vault but little.

In a very good paper, Merkel (1882) proposes his opinion that the body of the occipital has no influence, even indirectly, on the anterior half of the skull; he especially excludes the face. Merkel is firm in his belief that the portion of the skull anterior to a line or plane drawn from bregma to porion is much more stable in form than the portion of the skull posterior to that line or plane. Many of the other authors to be cited also focus their attention on the posterior portion of the skull, for one reason or another.

Toldt (1910), although not the first to create the distinction (he was preceded by His with Rütimeyer, 1864) had the greatest influence in the general acceptance of the dichotomy between planoccipital and curvoccipital brachycephaly. According to Toldt, the chief difference between short and long skulls lay in the build of the posterior portion of the vault. The dolichoid skulls were well arched posteriorly; the brachyoid skulls were always short, steep, and more or less flat in the rear. The skulls in his collection which were fairly long, but still possessed a little flattening in the occipital region he labeled, charmingly enough, "Unbekannt."

Toldt (1910: 223), after considering the various bones of the skull vault, came to the following, and somewhat discouraging conclusion: "Es darf vielmehr als erwiesen betrachtet werden, dass die verhältnismässige Wachstumsgrösse der einzelnen Knochen, der Schädeldecke sowohl als der Basis, bei allen Schädelkategorien sehr beträchtlichen Schwankungen unterliegt und innerhalb gewisser Grenzen von der Schädelform unabhängig ist." Other authors, as we shall see, are not so pessimistic about the skull base.

Reche (1911: 74–75) admits with Toldt that the chief difference between dolicho and brachy skulls lies in the build of the rear of the skull. But he extends this difference to the bregmatic region and introduces a new index:

$$\frac{100\ \text{L.B.}}{\text{Br. Op.}}$$

in which L.B. is the length of a perpendicular dropped from lambda to a line drawn from bregma to opisthion. He claims this index to be better for differentiating brachys from dolichos than the cephalic index; and besides it needs only the median sagittal plane for the diagnosis. Without criticizing this index too thoroughly — although one can hardly resist remarking that the part played by the bregma-opisthion diameter needs watching — we record for our present purpose that Reche holds that the parietal bones are also sufficiently different, in brachys and dolichos, to enter into the differentiation of the two types.

From a racial point of view Giovannozzi (1909: 114) had already divided the brachycephals of Europe into two types: the hypsicephalic, armenoid peoples (inhabiting mostly the territory of the Balkan Peninsula to Hungary, inclusive), related to the brachycephals of Asia Minor; and the platycephalic, monogoloid folk, one of whose centers was in the eastern Alps, especially in Carinthia and the Tirol.

Other authors keep insisting, however, on the mutability of the occipital region. Angelotti (1915–16: 29) concludes his study of dolicho- and brachymorphy by saying: "Ho mostrato anche che tali differenze interessano sopratutto la parte posteriore del cranio nella zona sopra-iniaca." Angelotti maintains that the two types, dolicho- and brachycephalous, are results of internal forces only. Zanolli (1914) and Giuliana (1921: 153) remark on the extreme variability of the occipital bone, a variability greater than that exhibited by any other bone of the brain case.

Mair (1926: 663) introduces a different approach, and an interesting one. He writes: "Das Windungsrelief der Aussentafel gibt beim Erwachsenen nicht immer den wahren Stand der Furchen und Windungen wieder, sondern einen den kindlichen Verhältnissen entsprechenden; die tatsächliche Form prägt sich nur mehr an der Innentafel an und zeigt in vielen Fällen einen ausgeprägteren okzipitopetalen Typus als der Aussenschädel." A detailed study inspired by this suggestion would be difficult to carry out, but might yield illuminating results (compare Weinmann and Sicher, 1947: 85). Even more fruitful, I should think, would be an extension of the work of Abbie (1947) who brings out (p. 241) a point of extreme importance, if corroborated: the ectocranial indices and the endocranial ones conform more closely throughout the ectocranial range of 79.8–82 than anywhere else in his series. This is one of the many reasons why Abbie takes this range for his mesocephaly, considering skulls above or below this range to be deviants from the original modern human form.

Mair's use of the word "okzipitopetalen" brings to mind Froriep's (1897) proposition of a fundamental difference in skulls with which every observer of man's physical variations has wrestled at one time or another. His distinction between frontipetal and occipitopetal heads is echoed in Keith's (1925) preoccupation with the pre-auricular and post-auricular lengths; later on in this chapter, I shall return to this distinction, in discussing Davenport's (1940) struggles with a wandering porion and a growing post-auricular length.

Froriep's distinction keeps reappearing in the literature, because it seems based on fact. In 1926, Thorsch performed experiments to see whether it could be corroborated. He reports that a line dropped from the center of gravity of an ordinary set of skulls falls very near the porion; hence Froriep's dichotomy is valid.

However, some of the work built on this distinction does not impress me unduly. For instance, Shindo (1913: 711) claimed that in general uncivilized peoples were frontipetal and civilized, occipitopetal. As he draws this conclusion from observations on 37 skulls (17 "European," 3 "Asiatic," 2 "American Indian," 4 "African," and 11 "Oceanian"), one could well await corroboratory illumination from more extensive material. Until then, I preserve the liberty to say that this reminds me of the seductive but not too solid views of Nystrom (1902), that the differences of civilized and uncivilized heads were essentially created by living habits, such as work-posture.

Taking a very different direction, many craniologists have noted the phenomenon that the skull base remains relatively stable amid the vicissitudes that obviously affect the vault bones. Tschepourkowsky (1911) claimed that the skull base was from the very beginning of life racially differentiated. The Negroids, she says, have the longest, the Monogoloids the shortest skull base of those with like cranial index. She wonders whether the skull base may not be thus differentiated because it is intimately connected with the facial modulus. She adduces evidence from deformed and undeformed Peruvian skulls, in which there were spectacular differences in the vault, but practically none in the skull base. She also claims that the heredity she observes in the case of the cephalic index agrees with this stability of the skull basis.

Pfuhl (1924: 78) finds the pars basilaris of the skull the best for the registration of heredity in the skull region. His rather practical

reason for rejecting the vault for this purpose is that this region suffers considerably from birth deformations and from accidents occurring to the young skulls during transport and laboratory treatment, and from the vagaries of growth anomalies. He himself (p. 79) uses the dimension nasion-basion-inion as an expression of the skull length, and he avers that the cephalic index is even worse as an indicator of heredity in the case of the newborn than in that of adults. He claims that the skull depends for its form on the forces exerted by hormonal substances, and adds the somewhat difficult admonition that each skull should be evaluated as a whole.

Observations on the growth of the skull base have been made by Brodie (1940). It is clear from the graph he gives (p. 745) that the growth of the cranial base from six months to eight years has two phases. After 1.5 years of age, all the lines of growth, including this one, are straight lines. But not in the antecedent period. The early growth of the cranial base is irregular. On the whole, however, the patterns of growth are incremental, and the persistence of early characteristics is generally clear. This does not surprise us.

The apparent stability of the skull basis is the foundation for the correction formula for deformed skulls elaborated by Shapiro (1928). There is reason to believe that racial complications rendered his formula less than absolutely accurate; the material he worked with does not seem to have been perfectly adapted to his needs (von Bonin and Morant, 1938; Stewart, 1940).

That the skulls base can suffer considerable change in sympathy with deformation of the vault is suggested by Oetteking (1924), who describes the declination of the pars basilaris in deformed San Miguel Island and Chinook Indian skulls as being greater than that found in miscellaneous European skulls; the angle of the foramen magnum also seems to be changed. The comparative material, in view of the racial factor, is unfortunate; but confirmation of the positional changes of the pars basilaris is afforded by Taeger (1930: 336); and Falkenburger (1938: 31–33) shows that the angle of the clivus is characteristically different in strikingly deformed and in normal skulls, while Stewart (1943: 167) demonstrates that the nasion-basion and nasion-prosthion lengths can be affected by deformations of Peruvian intensity; Newman (1947: 14) feels that nasion-basion length could have been reduced 4–5 millimeters in a series of skulls with extraordinarily heavy fronto-occipital deformation. Results of limited deformation, of course, would not be particularly noticed in an ordinary craniological study, and the dimensions and angles would be included in the averages and ranges usually published.

However it may be with the skull base (and it would seem to demand a pronounced deformity to change it much), it is clear from many studies that the upper face, in particular, is little modified by deformations of the brain case. Rivet (1909–10), in his study of prognathism, found no relation between this phenomenon and any skull shape. Falkenburger (1938: 21–22) judged that the relations of the cranial and facial capacity in deformed and undeformed skulls indicated that the face is little affected in the course of deformation. Comparing his data with those of Rivet (1909–10) and Fraipont and Leclerq (1927) and Vandervael (1932) on cranio-facial comparisons, Falkenburger concludes (pp. 29–30): "Il en résulte que la conformation du crâne facial est beaucoup moins influencée par le procédé de la déformation artificielle que celle du crâne cérébral."

It is true that Stewart (1940: 158) tentatively notes (on the basis of few skulls) that his Whitewater Pueblos showed a somewhat broader palate when suffering from lambdoidal deformation than did the normal skulls. But Riesenfeld (1946: 89–90) found no correlation at all between cephalic index and palatal area or palatal index, although his series runs to high hyperbrachycephaly.

In general, the experience of students has been that the face pursues a relatively stable course through the vicissitudes of cranial deformation. Hooton (1930) did not observe any striking differences between the faces of deformed and undeformed Pecos Indians. Hrdlička (1931: 92), commenting on the skulls of Pueblos, Southern Utah Basket-Makers, and Navaho Indians, writes: "The deformed skulls, after elimination of the infrequent cases where the base and face were obviously affected by the distortion, show but little if any disturbances of the facial indices or angles, or of the size of the skull. The moderately deformed

skull is therefore, after all, of some anthropometric value." Of course, where the deforming method is also applied to the forehead, the upper face may possibly also be affected. Thus, Hrdlička (1940: 456), summarizing his conclusions on the Gulf States Indian crania in the National Museum, says: "In deformed skulls the facial indices tend to be lower, owing to the fact that the fronto-occipital compression has broadened the vault and with it the bizygomatic diameter." However, "The total facial and the alveolar angle appear to be, to a considerable extent, independent of each other." Outside of such cases, the bizygomatic width should not be affected, as is indicated by Seltzer's (1944) findings on various Southwestern Indian groups.

I shall make a slight digression here, to include observations on the living, in order to to keep this brief discussion of the face unified. Boas (1911), interestingly enough, found that his American-born children of immigrants who changed their head form for a narrower one, also possessed smaller bizygomatic diameters. However, besides mentioning the fact that the differences were very small ones, we observe that such a difference is not universally found. Shapiro (1939) obtained an absolutely insignificant difference between sedentes, immigrants, and Hawaiian-born Japanese in this respect, even though the cephalic index changed by almost three points. Bean and Speidel (1923: 304) published the results of their study of a group of American soldiers; they found a difference of 3.01 points in the bizygomatic index (which I take to be the upper facial index) in favor of the subjects with flattened heads (N: 38) versus those with unflattened heads (N: 397). I suspect a racial complication in this case. In reverse, so to speak, we may quote Washburn (1946b: 172), who discovered in his experimental work on the rat that the form of the zygomatic arch had no direct effect on the form of the skull. Finally, I may adduce the results of my comparison of Lebanese and American Maronite upper faces, which show comparatively little mutability throughout the vicissitudes of change of cradling customs and change of environment.

A further compliment is paid the face by Pearson and Woo (1935: 463) who, in their detailed study of the individual bones of the human head, found that the face was more symmetrical than the brain case. The factor of homology — the only one that seemed to elicit respectable correlations for them — shows to best advantage in the face.

In view of all that has been said of the face (including inter-racial comparisons in the case of brachycephals, of which more in the subsequent section), we come to the conclusion that the face should rank high in stability and in probity as a source of racial diagnostics.

Our chief concern in this study is with the varying fortunes of head form at an early age, specifically during the first year of postnatal life; later stages interest us only from the point of view of the persistence or nonpersistence of early form. Hence, the question of the part played by sutures (Weinmann and Sicher, 1947: 80 ff.) and suture-closure does not require extensive examination here. From the point of view of permanence or nonpermanence, however, we note that much modern opinion is to the effect that the sutures play a very subordinate rôle in fashioning head form (e.g., Troitsky, 1932: 530), and that suture-closure is not the cause of abnormal forms, but rather the expression of the fixation thereof (Mijsberg, 1932: 550). Aichel (1926) reviews the literature up to his time and concludes that in a very limited number of cases suture-closure seems to cause the abnormal form; however, none of these forms is hyperbrachycephalic and planoccipital. Aichel has a useful table of abnormal skull forms (pp. 28–30).

I have already mentioned the importance of Hooton's (1930) monograph on the Pecos Indians to the conceptual background of this study.

Other studies on craniological material will appear in subsequent sections of this chapter.

The Problem of Brachycephalization

Strictly speaking, the problem of this study is that of the causation of hyperbrachycephaly. It is, however, impossible to set the essential boundary between hyperbrachycephaly and ordinary brachycephaly. It would seem possible that certain agencies of an external and mechanical nature are adapted, with a certain lessening of their duration, effectiveness, or rigors, to a production of brachycephaly on the nascent head. The agencies I have been discussing may become impious enough to

allow their effects to cross the numerical boundary line between the two categories. In addition, it will appear that the literature on the problem of brachycephalization contains much that might shed light on our central problem.

Our interest in this literature is not by any means motivated by a naïve desire to prove that early postnatal treatment is capable of solving the problem of brachycephalization. I simply cite such items from the literature as might indicate that this treatment may well have been one factor in the production of the interesting head form in question.

In view of the facts already submitted, and to be submitted, I cannot agree with Weidenreich's statement (1945: 41): "Recent man shows a tendency to become more and more brachycephalic. The development of hyperbrachycephalic forms seems to be the latest step in this direction." I am not against the tendency; I am for bounds set to the manifestation of that tendency.

Reicher (1914: 60–64) is puzzled by the fact that, when he compares the differences of the means for the brain case and the facial structure as between European and Mongoloid brachycephals, he finds practically no difference in the brain case, but a great difference for the face. He asks whether this could possibly be convergence; or should we consider the facial skeleton intrinsically more variable than the skeleton of the brain case? He concludes: "Wir können nur annehmen, dass die übereinstimmende brachycephale Form sich wahrscheinlich bei beiden Rassen unabhängig herausgebildet hat unter ähnlichen oder auch verschiedenen Einflüssen, die jedoch dasselbe Resultat bedingt haben." Reicher's weak explanation leaves the fact clearer that the purely metrical consideration of the two types of skulls is not at variance with the hypothesis that the brain cases have been affected by similar mechanical forces, whereas the faces show a racial difference such as one should expect between Europeans and Mongoloids.

The similarity in the occipital bones of Lapps, European Alpines, and Mongoloid brachycephals found by Blomquist (1939) would further increase Reicher's puzzlement. Because we know something of their customs, however, we may be allowed to feel that we have isolated one factor in the production of brachycephalic shape.

A similar phenomenon engages our attention when we turn to a part of the lengthy, detailed, but not too illuminating discussion by Gerhardt (1937–38) of brachycephaly. Here he is considering the relations of the Armenoid type of skull and the "Turanid" race. Gerhardt presents the difficulty against regarding the peoples of Pamir, and Hindu Kish, and Turkestan and of central Asia as members of the Alpine race; the unity, he well says, is merely that of brachycephaly — the rest of the somatic characteristics are quite different. "Es liegt vielleicht hier," he writes (p. 442), "ein ähnlicher Fall vor wie bei den alpenländischen und vorderasiatischen Planoccipitalen; auch bei diesen sind die Schädel ausserordentlich ähnlich, dagegen die somatischen Merkmale voneinander abweichend." We may recall here that such planoccipitals as the Maronites in the Lebanon and the Albanians and Montenegrins in the Balkans have identical cradling customs — which clearly produce this planoccipitaly in the case of the Maronites.

Kohlbrugge (1935: 71) states that the brains of brachycephals, all of them, show "une grande analogie," which he describes. There is no determinable difference, he says, between the brains of, e.g., Chinese and European brachycephals. Basing his conclusions largely on the work of Kappers (1932), Kohlbrugge (1935: 81–82) is sure that measurements are useless in distinguishing the different racial types of brachycephalic brains, and that the closer study of sulci and convolutions is just as meaningless.

It is far from my intention to venture onto the much-harried field of European brachycephaly as the protagonist of a simplistic theory. But I cannot ignore this field and its problem entirely. The "excessive brachycephalization which swept over central Europe in the Middle Ages, affecting especially southern Germany and Bohemia" (Coon, 1939: 10) is a phenomenon not entirely alien to this study. This is true in particular of outspokenly "Dinaric" regions; and also of regions containing a high percentage of hyperbrachycephals. At the very least, I have proposed a cultural factor which must be taken into account by the measurers of heads. Since I have demonstrated that a major Dinaric "racial" characteristic is nonhereditary, a re-examination of the problem of Dinaricization (Coon, 1939: 600–02) is in order; as well as of the

racial analyses made of Dinaric peoples. Such a re-examination, it is to be hoped, will shortly be made on Dinarics from Albania and Montenegro; a preliminary statement regarding planoccipitaly and these peoples has already appeared (Ehrich and Coon, 1948), in which the non-racial nature of the flattening is emphasized. Ehrich was led all the more to this opinion by his comparison of the Atlanto-Mediterraneans and Dinarics he had isolated out from his Montenegrins; he found that significant x p.e. were found only for parts affected by cradling (Ehrich, 1947); this corroborated my own opinion that there was no such thing as the Dinaric race. It would seem that a factor in the influence on high brachycephaly of the Asiatic invasion of Europe (Hooton, 1946: 497–98; Weidenreich, 1945: 30) has been uncovered; that this factor may have played a rôle in the production of brachycephaly, too, seems plausible — for what can produce a drastic, striking result, can also produce a lesser result in the same field.

However far it may be from my intention to attempt to discuss fully European brachycephalization, a few samples from the literature on this subject will not appreciably distract us from our general theme; in fact, we may find some points of interest and value in these samples. The problem is attacked in numerous publications (e.g., Weidenreich, 1945: 21 ff.; Coon, 1939: 510 ff.). Županič (1937–39: 322–25) sets forth tables showing the radical difference in head form of the Yugoslavs of the seventh to tenth centuries A.D., and of the present. In 1919 (p. 22) Županič opined that the increasing brachycephaly thus indicated was introduced by the Mongols. Matiegka (1912) claims that the newer, brachycephalic Slavs grew out of the older, dolichocephalic ones. Others disagree with him. Schwerz (1912: 623) presents curves of the cephalic index for the Alemanni and for modern Swiss from the same area; these curves might have been copied from my own curves for the Lebanese and American Maronites. Much more impressive, however, is the information collected on the successive populations of Switzerland by the same author, and presented synoptically in a table (Schwerz, 1915: tafel 142). We note from this that Swiss populations from those of the Neolithic up to and including the Alemanni, differ from the modern Swiss essentially in head form — but the indices and dimensions of the face have changed but little. It reminds me of the situation analyzed among the Pueblo Indians by Seltzer (1944). On the other hand, I may interpose mention of the fact that the faces of European and Asiatic Dinarics can be very different (Mollison, 1931–32; Krogh, 1938).

More concentrated attention has been paid to German brachycephaly by E. Fischer and his school than by any other group. It is, therefore, of some importance that we cite his views on the subject. He quotes (Fischer, 1924: 39) Ammon (1899) with approval: "Doch könnte die Kreuzung allein nicht erklären, warum die Körpergrösse des nordeuropäischen Typus und dessen Farben weniger beeinflusst wurden als die mit der Grösse in inniger Verbindung stehende Kopfform. Wenn nicht angenommen wird, dass die Auslese mitgewirkt hat, bleibt die Entstehung dieser merkwürdigen Verbindung unverständlich." Ranke, says Fischer, proposed, and with justice, the leptoprosopic, brachycephalic type as the main racial type of southern Germany. Fischer (1924: 44) sums up his ideas thus: "Die Schädelform, d.h. die Grössen der Hauptdimensionen des Schädels sind an sich erbliches Rassemarkmal, d.h. beruhen auf Erbfaktoren, vererben sich also selbstverständlich nach den Mendelschen Gesetzen. Aber ebenso selbstverständlich wirken auf diese Merkmale die Umweltfaktoren ein, und der Phaenotypus, also das was wir mit Auge Massstab feststellen können, ist das Produkt beider Faktoren." These last are the "peristatische Faktoren" that Fischer proposes as an explanation of the anomaly of southern German brachycephaly. Gerhardt (1937–38: 403) sums up Fischer's ideas even more dramatically, especially with regard to the value of the cephalic index in this whole problem: "Danach ist es unmöglich, dass die 'Brachykepalisation' hauptsächlich auf Einkreuzung der curv- oder planoccipitalen Typen beruht; auch eine Änderung des Genbestandes wird von E. Fischer mit guten Gründen abgelehnt, so dass nur ein phänotypisch wirkender Umwelteinfluss übrigbleibt, der uns aber *so gut wie unbekannt ist.* Damit ist aber in diesem Falle die Beurteilung eines Schädels (Kopfes) auf Grund des LB-

Indexes so gut wie völlig aussichtslos." (Italics are mine.) I have, I think, proposed in this study one very plausible factor in the "Umwelteinfluss" which has become so important a consideration with regard to this problem.

Weidenreich (1945) sees in brachycephalization (no matter how abrupt it may be in various regions) a continuation of a general process which started a long time ago in the history of man's head, and continues to the present. That this has been the case he proves with many examples, most of them well known. I should be very happy to see this problem attacked by an experimentalist; for instance, an extension of the work of Schultz (1942) on the balancing of the head among the Primates to include various categories of modern heads would be one of the possible fruitful approaches to a factual evaluation of many theories on brachycephaly and the erect posture.

One attack on the problem of head form has been by way of studying the genetics of this phenotypical part of the categorization of mankind. The name that springs to the lips in this respect is that of Frets. According to him, the problem is not simple; I may well agree with him, and doubt at the outset that he is going to solve it by a multiplication of group, individual, and familial cephalic indices alone.

Frets (1925: 79) states that the factors for the three dimensions of the head cannot by themselves explain the heredity of head form. We must assume factors for form, as well as size. These factors are independent. The factors for head form show dominance, whereas those for head size are probably intermediate. For head form and head size Frets accepts an equal number of multiple (polymere) factors. For head form there is also multiple allelomorphism. Sometimes, in fact most of the time, brachycephaly is dominant. The situation is further complicated by the fact that the two sexes can differ in any mentioned respect.

In 1931, Frets (p. 516) comments on the findings of Roest who measured the children of Dutch and Javanese parents, and notes that brachycephaly is dominant in the cases in which the mother is the brachycephalic parent. In such a situation, I should like an investigation into just how much the mother, in these marriages, follows native customs in rearing the child. Such matters are usually left to the mother, especially when the child is very young; the strong presumption exists that many Javanese are brachycephalic precisely because of early treatment. However, the point of Fret's remarks is at the end of his paper; there he states that he once found dolichocephaly dominant, and he asks: are we dealing with different forms of dolichocephaly and brachycephaly, in our sundry investigations? He returns to the old distinction between plan- and curvoccipital types, and concludes (as do so many scientific papers) with the plaintive remark that we need more data.

Geipel (1938: 126) holds that there is a pair of genes for the cephalic index, and that inheritance is intermediate. Mesocephaly is split inheritance. It is difficult to agree with Geipel, in the present state of our knowledge.

Neuert (1937: 145) notes that among the newborn of Europeans, the cephalic index of the infant tends to follow that of the parent with the lowest index. This is an interesting, and possibly important, observation.

Other authors are by no means convinced that simple Mendelian inheritance of head form, and specifically of brachycephaly, is a proven and clear process. With regard to the brachycephalization of Europe, Coon (1939: 10) writes: "Simple Mendelian dominance of brachycephaly, which has never been demonstrated, may not be eliminated, but it cannot have been the only factor involved." Brues (1946: 473–74) concludes from her study of various groups of European extraction in the United States that possibly dominance of brachycephaly is not at work in that country. Mühlmann (1932: 385) says that the dominance of brachycephaly is "keineswegs sicher." Abbie (1947: 239) may well write that "the inheritance of cranial characters seems to be a complex affair. . . ." The head breadth alone is the result of numerous factors; the posterior portion of the head is caused by still more. It is, therefore, on a very enigmatic genetical basis that Bunak's (1927) theory of the origin of the Dinaric head-shape was erected. This theory (developed and modified by Hughes, 1938b; Coon, 1939; and Kherumian, 1943) presupposes the inheritance of the anterior and posterior portions of the head, each "en bloc";

the anterior being of "dolicho" ancestry, the posterior of "brachy" origin, the fusion results in the dysharmonic Dinaric. Even apart from my proof of the deformation of the posterior head, this theory was bound to remain speculative, because of our current inability to separate out individual genic factors.

However, the frequent appearance of regularity obtained by such workers as Frets, Boas (1899; 1903), and many others, strengthens one's a priori opinion that basic head form should show obedience to the general laws of heredity. That head form is, indeed, not more irregular than it is, results from the working together of hereditary and nonhereditary factors (one of the latter may be infant treatment) towards the production of a normal curve, if I may so express it. The difficulty in isolating out hereditary and nonhereditary factors is highlighted by the painstaking study of Pearson and Woo (1935). These workers, using Egyptian skulls for material, made numerous measurements of the individual bones of the skull and then applied all their statistical resources in the attempt to discover relationships between the bones. They (p. 464) came to the conclusion that neither size nor contiguity yielded any discernible relationships; the only factor that seemed to eventuate in useful correlations was that of homology. They are forced to conceive the heredity of the brain case as being simply a matter of the heredity of the brain itself, which the brain case, as it were, incidentally covers. A glimpse of the complexity of the skull is given by Weinmann and Sicher (1947: 83), from a developmental point of view: the enlargement of the skull, they tell us, is primarily dependent on cartilaginous growth (as seen in the spheno-occipital synchondrosis, for example), on proliferation of connective tissue in the sutures, and on surface apposition of bone in many different areas. The third factor is the most important; but all three would certainly seem to allow many opportunities for individualistic variation induced by external forces.

The potential for drastic change resident in "environment" is indicated by recent work on twins. So, for example, von Verschuer (1931–32: 55; 1925) finds that there is a large difference between monozygotic twins with respect to the cephalic index, a difference that can be attributed only to environmental forces. Abel (1934: 341) cannot come to any definite conclusion about the inheritance of head dimensions, but he does (p. 281) suggest that the deviations of the length and breadth of the head are greater for dizygotic than for monozygotic twins. The environment masks heredity, in great part. This stands out, too, from the pages of general studies, such as those of Newmann, *et al.* (1937; 1940), as well as from such striking individual examples as that published by Sullivan (1919) on the "Siamese twins" from the Philippines, whose indices differed markedly. It must be remembered, too, that environment does not wait for the time of birth, before getting to work. In fact, prenatal environmental influence causes a later difficulty in the diagnosis of monozygotic twins.

The obviously important action of environment on the human organism has often been handled under the catch-all heading of "Domestication." This has been thoroughly discussed in an excellent paper by Weidenreich (1925), who also gives a review of pertinent literature. Much attention has been given to the effects of domestication on animals; in this connection the names of Hilzheimer (e.g., 1913; 1928) and Klatt (e.g., 1913) are complementary. Klatt, incidentally (463), makes a good but discouraging observation to the effect that we can determine racial characteristics on animal skulls only when we understand them causally. This is true, too, for human beings. That is, when racial characteristics are not just museum labels, but essential and dynamic knowledge.

The combined influences collected under the name of "Domestication" are not lightly to be tossed aside (Schwidetsky, 1940); but, on the other hand, in the present state of our knowledge, the limitations of this multiplex conditioning as an explanation are considerable (Mochi, 1921). The various elements that enter into its composition need more detailed study.

A few investigations on the effects of one or other factor in external environment have been made. One such is that of Iwanowsky (1925) on various groups in Russia that had suffered from a famine. He found that the cephalic index was lowered (with the exception of that

of some male Armenians, Grusines, and Tatars of the Crimea), but returned to normal for the most part by four months after the end of the famine. This is tantalizing. What exactly happened to the muscles we may well presume to have affected the head breadth? What would happen after several generations of successive (but not continuous) famines? Why did the exceptions occur? Changes in other respects have also been noted, although with less clarity, on the same sort of subjects by Stefko (1924). Hooton (1946: 495–96) compares the changes obtained by Iwanowsky, and those of Boas (1911) on immigrants and their children, and draws the conclusion that environmental differences, especially those affecting growth and nutrition, may thus alter the cephalic index by some two or three per cent. Nothing, by the way, so great as the changes I have found between the cradled Lebanese Maronites and their uncradled American descendants. It is hardly possible, at all events, that the small changes noted by Iwanowsky (which presumably occurred in the soft parts of the head) should be of permanent importance. Weidenreich (1925), however, points out that there may be great importance in long, successive generations of living under conditions which produce not exactly a sickness that may be diagnosed but a near-sickness that allows the subjects to live almost normally.

The possibilities inherent in the application of active experimentation on animals to the problems of anthropology have not been by any means adequately explored (Washburn and Detwiler, 1943; Washburn, 1946b: 169). Fick (1859) was a pioneer in this field, but the list of names of workers who have followed him up is short, and the years between the various publications many. The chief result of Gudden's work (1874: 34) was the realization of the reciprocity of accommodations between the brain and its bony capsule. In a general way, this realization emphasizes the importance of the contents of the capsule in exerting formative force on their container. It makes a skull, therefore, not just a husk which has autonomously and independently grown around a brain, but a product of its own intrinsic growth forces and those of the brain as well. Important as this concept may be in the realm of theory, its application to our immediate problem may seem small in the present state of our knowledge. But I may interject that our ignorance also offers no reason why the posterior portion of the brain should tend to produce a flattened occipital bone.

Walkhoff (1903) studied the effects of excising the larger portion of the M. temporalis in the dog, and the resulting deviations in the temporal lines. Neubauer (1925: 415–24) has a long and capable description of the results of his tampering with the neck musculature in animals.

Of more recent date, the chief class of investigators interested in this work has been that of the orthodontists. We have already mentioned many items of their work in the discussion of the bigonial measurement on our Maronites. Naturally enough, these students have been chiefly interested in the teeth and the face.

The results achieved by evulsing teeth have been noted by many (e.g., Gudden, 1874; Du Bois, 1911), as well as the influences of the occlusion and eruption of teeth (e.g., Baker, 1941). Rouvière (1939), an anatomist, presents experimental work much like that of Walkhoff. Pratt (1943) removed the masseter muscle of young rats, and noted changes in their skulls as a consequence. Washburn (1946a and 1946b) has shown the changes resultant on the removal of the zygomatic arch and the cutting of the seventh nerve in young rats. A great deal of detailed work, including accurate statistical comparison of measurements of control and experimental animals, badly needs to be done. However, I think that such experimental work alone will not solve all our problems. I have noted, in discussing the bigonial measurement of my Maronites, that muscle influence seems to affect and sculpt what is already, in its main lines, laid down. While experimental work is important and needs doing, heredity and endocrinological studies must be joined to it.

General results of experimentation concerning the effects of nutrition on form and size have been made by physiologists, but not many have come to my attention in which measurements more or less applicable to anthropological problems are supplied. Such experiments, especially on young animals or on the effects

experienced by newborn animals of the feeding done by the mothers, should have much value.

Von Nathusius (1864) is one of the pioneers in the field of animal nutrition studies. He noted (pp. 100–01) that well-fed swine differed little from poorly fed swine of the same kind in length measurements, while the breadth measurements were often conspicuously different. Specifically, for our problem, the swine were more brachycephalic when well fed. Klatt (1913) notes that bigger animals tend to be more dolichocephalic. Neubauer (1925) found, on the other hand, that the rats which had been deprived of their rightful share of vitamins were all more brachycephalic (pp. 435–38). He compares his results with those of Henseler (1913–14) on swine; and notes the difference of technique used. Henseler fed his swine on a generally poor diet; Neubauer created specific vitamin deficiencies. It seems quite general that domesticated animals are shorter-headed than their wild congeners; it is hardly demonstrated that the nutritional factor is the sole or even the determining one in bringing about this effect.

Roth (1935) worked with alkaline injections of anterior pituitary extract, and with orally administered thymus gland. In general, the first led to giant growth; the skull length relative to body length became smaller, but the skull was absolutely lengthened, particularly the nasalia; the skull breadth was not essentially increased, but the bizygomatic diameter was much larger. The effect of thymus-feeding was quite different. The rate of growth was increased, but the animals did not reach the dimensions of the other set. The skull breadth gained somewhat; the bizygomatic diameter gained little. This study shows that there is a crying need for much more of the same kind of work.

One of the few cases of actual experimentation on living human beings, and one which is intimately connected with our problem, is that of Walcher. In 1905, he reported on his treatment of 555 children born in the institution (a mid-wives' school) to which he was attached. These children were divided into groups: some were placed on their sides, with the sides of their heads resting on a fairly hard, horsehair-filled pillow. They were occasionally changed to the other side, when their heads showed asymmetries from being kept too long on one side. The other children were placed on their backs, their occiputs resting on a soft, feather-filled pillow. The reason for the two types of pillows were: the hard pillow would make it uncomfortable for the child to rest the protruding occiput on it, and the child would tend to keep on its side; the soft, fluffy pillow would discourage the child from turning on its side, as the pillow would then interfere with breathing.

The results are reported by Walcher (1905a and 1905b; 1911; 1914; the last being a report of a lecture given on the subject before the Würtemberg Anthropological Association), and by Elsässer (1906), and a résumé is appended to his own researches by Basler (1927). Walcher himself (1905a) is most jubilant over the reaction of two monozygotic twins, one of which became dolichocephalic, the other brachycephalic as a result of varied treatment. But I am more interested in the percentage table of results (Basler, 1927). Of those who had been placed on their back, 84.1 per cent increased in cephalic index, the amount being +3.75 points. Fifteen per cent showed negative results, by −1.39 points. The children who rested on their sides had 62.7 per cent whose cephalic index had been reduced, by an average of −2.56 points; 37.3 per cent showed negative results (i.e., negative for the desired and expected effect) by +.66 points. All this took place in thirteen days. Walcher (1911) insists that the greatest effect is made during the first weeks and months of an infant's life. He speculates on the effect of his discovery on the picture of man's cranial history, back through the ages. In this publication he also gives silhouettes of various children's heads, and good photographs of the twins involved in his best-loved experiment. In his 1914 reference, nothing new is added, but we note that he brought some of the children he had experimented on (now, no doubt, walking) for inspection by the Würtemberger anthropologists.

Many years later, Basler (1927) attempted to determine whether any effect produced during the extreme youth of these children had remained recognizable in adult life. Walcher's experiment was, in many respects, naïve. He never mentions any appreciation of the changes of the cephalic index that may occur within the first few days after birth, as

a result of readjustment after that process (a point I shall discuss in a subsequent section). He does not seem aware of any racial factor. Since he was a medical man, perhaps his lack of statement concerning pathological findings indicates that there were no such complications. The most unfortunate lack was that of properly kept records; Basler had great difficulty in locating the subjects of his experiments, in later years. However, Basler did succeed in tracking down twelve subjects with certainty, and he reports that these twelve had retained their modified cephalic index to a certain extent. Knowing more of growth studies than did Walcher, we appreciate the fact that he protested too much. He declared that the form of the head at the end of the first year of the child's life was the form that persisted throughout adult life. This is going too far. But, as will appear, one is justified in expecting a modified head form to be retained with the change of only one or two points, as a rule. This question of the permanence of youthful head form is not so burning a one as it was in the past; the literature on artificial cranial deformation and my results on the Maronites have shown, I think, that noticeable externally induced changes in the head form are sustained into later life. The question, if posed as regards less marked changes, will receive an answer in later discussions. In spite of the small number Basler could find for his follow-up of Walcher's subjects, the resulting impression from their combined work (an indication like a straw in the wind) is that early treatment can have a lasting effect.

Many criticisms of Walcher's work, and suggestions for improvements, have been published (e.g., Marlinger, 1912, who suggests that the children should be allowed to choose their own postures, and then divided on a hard and soft pillow basis), and many statements made concerning the unchangeable nature of the cephalic index (e.g., Pfitzner [1899: 376], "Der einzige unveränderliche Charakter"; and the conclusions of Pearson and Morant, already cited), but very few have resorted to further experimentation to prove or disprove the indications given by Walcher's work. And on the whole, anthropological literature, with the exception of an occasional small nod in the direction of what might be at best a very minor factor in disturbing the metrical perfection of the cephalic index, has not been concerned with the whole matter.

However, Kruse (1934: 1755), after alluding to the universal change in cephalic index during the first year of life, insists on the strong influence of environment evident from twin studies. He claims that he, M. Fischer, and Catel have corroborated the results of Walcher. Kruse's own work was done on 14 subjects, and strong assertions are not to be founded on such a tiny foundation. Davenport (1940: 72) indicates, and rightly, that Kruse minimizes the importance of heredity in this problem. Davenport also adds a remark which echoes one of Hooton (1920: 89); namely, that children dolichocephals by heredity would find it more difficult to lie on their occiputs than brachycephals. So perhaps environment may often accentuate a hereditarily determined form; for the reverse could well be true of hereditary brachycephals. Certainly, the experimental work of the future should be much more meticulous than was that of Walcher. More refined categorization should be achieved; technique should be more accurately described — for instance, it makes some difference in this sort of study whether the head length is measured in the median sagittal plane, or wherever the greatest length is found, in the case of asymmetry.

Much more important than the work of Kruse is that of Catel and Grube (1934), although, sadly enough, it, too, suffers from lack of numbers. These two investigators employed a total of 30 children, 21 premature babies, and 9 evidently normal (p. 130). At the beginning of the experiment, these children varied in age from two to eighty-eight days; the experiment was carried on for from three to twelve weeks. There are, unfortunately, entirely too many papers published with statistical support of such a tenuous nature. Eighteen children were pillowed on horsehair-filled pillows and forced to assume a side-lying position; 12 were laid on their backs, their heads on soft pillows. In this technique, Catel and Grube were following Walcher's lead. Groupings that one could desire were not made: e.g., cephalic index groups with length of experimentation, state of nutrition, weight at birth, etc. The main criticism I should make of their work, however, is that the time of

experimentation was entirely too short to assure reaching satisfying conclusions. Their subsequent observations on the infants are valueless since there was a lack of control of experimental conditions (the infants had been returned to their homes).

On the whole, the conclusions reached by Catel and Grube are of two kinds: immediate and general. The first kind includes the statement that strong dolichocephals are more easily influenced to the opposite head form; that in the case of the brachycephals hard or soft pillows make no difference; while dolichocephals need hard pillows and then easily revert to type. The general conclusion: the head form of an infant can, with limits, be influenced, but only so long as the influencing factor is acting; by the time the definitive head form has been achieved, hereditary factors are of vastly greater importance than environmental. I disagree with the conclusions *as* drawn from the experiment; but I reiterate my stand that the heredity-element is a differential in this problem.

Catel and Grube, and many others, forget, it seems to me, the inherent complexity of any situation which deals with human heredity and environment. We never find a hundred per cent of any group on which head deformation is at work, to be deformed in the same way and with the same intensity; there are too many variables involved. An experiment concerning the subject in hand that would adequately deal with even the major variables should be a complicated and careful experiment indeed. And it badly needs doing.

General Anthropometrical Literature

I shall not delay long over conclusions concerning our problems, deduced from the anthropometry of single series. Only work which participates of the nature of the experimental is capable of settling the questions we are studying.

The conclusions of anthropologists have clustered about the central brand of opinion expressed by Coon (1939: 600); namely, that cradling may intensify an occipital flattening which is already present because it is hereditary and racial in character.

As neat a row of opinions as I have found is listed by Petroff (1931); his paper is concerned with an area which is of great interest to us, the central Asiatic area.

Petroff cites: Oschanin and Jassewitch (1929) as thinking that the effect of the cradling is easy to discern among the Beshik, but that nevertheless there are some among them who are genotypically flattened, without the help of artificial deformation; Zimmermann (1927), who states that the flat occipital region of the Usbegs is completely an artificial product; Bunak (1932) who tends to think that the flattening is genotypical among the Armenians; Pokrowskj (1900), who opines that the possibility of cradling having some effect is proven, but that that effect is almost solely confined to asymmetries of the skulls; Anutschin (1887) as thinking it possible that occipital flattening be caused by cradling; Chantre (1881; 1891; 1895), who is sure that this is certain; as is Giltschenko (1890), in his study of the Ossetes; finally, Gerschenowitsch (1929), who remarks on the lessening of the amount of flattening as the subject grows older, among the Usbegs. It is this last point that determined Petroff to make a study of the phenomenon with Irani subjects.

Incidentally, opinions like these (although by no means unanimous among Russian anthropologists, nor confined to them alone) excited Gerhardt (1937–38: 414) to make the following scornful and erroneous remark: "Die besonders von älteren russischen Autoren immer gern beigebrachte Erklärung für die genannten hohen Indizes . . . , sie seien durch Kopfdeformation mittels der Wiege im frühesten Kindesalter verursacht, ist zwar bequem, aber kaum überzeugend, da eine derartige unbeabsichtigte Einwirkung sich kaum bis ins Erwachsenenalter erhalten wird. Ausserdem kann sie nicht in einem so starken Masse erfolgt sein." I think Gerhardt would delete that passage, now. In quite another area, that of the European Dinarics, Maleš (1938: 284) holds the hypothesis that Dinaric flattening may be due to cradling to be a thoroughly respectable one. Speaking very generally, Hooton (1946: 501) indicates that pressure on the occiput (or elsewhere) during infancy may be one of the possible factors in inducing the final head form.

To return to Petroff, who (1931: 505 ff.) studied the relations of age and occipital flat-

tening among the Irani. He finds that the length and breadth of the heads increase from age-group to older age-group, but that the flattening (p. 508) seems to be about the same at all ages. He obtains a general correlation between length and flattening of .76, and between breadth and flattening of .645. His final conclusion is (p. 509) that the cradle sometimes has remarkable effects on the racial form, but that the flattening is genotypical in some cases, at least most probably. I cannot agree with this last conclusion.

Müller (1935), dealing with the peoples of southern Asia, mentions artificial deformation, and specifically occipital flattening. But, he says (p. 85), this cannot have been caused merely by presure on the occipital region, because there is no trace of effect on the frontal portion of the head. I think we have already disposed of this line of reasoning.

Since I have already had occasion to mention many studies and opinions drawn from purely anthropometric work, I shall not continue this discussion further, but will satisfy myself with the consideration of a comparative series (in addition to those already cited in Chapter II) which is cognate to our present study. That series is the one Boas (1924) proposes, comparing Asiatic and American Armenians. Boas gives data on 74 Armenians born and raised in Asia Minor and on 9 adult Armenians, born and raised in the United States, together with 7 children also of the United States. I consider here only the males, for purposes of strict comparison.

One notes immediately that the number of United States Armenians is lamentably small. On the whole, these series yield data comparable to my own. The differences, for the adults, are: head length, +6.4 in favor of the Americans; head breadth, −3.9, the Asiatic Armenians being broader; cephalic index −5.0, the Asiatic Armenians being 85.6, the Americans, 80.6. The seven children have an average cephalic index of 82.5.

So far, so good. We may reasonably assume that the Armenians, like the Maronites, gave up at least the larger share of their cradling habits when they migrated to this country, and that the head form of their offspring would thus be different. Boas (1924: 81) concludes: "Der Unterschied der Kopfmasse zwischen beiden Gruppen ist so gross, dass es nicht wahrscheinlich ist, dass er auf dieselben Ursachen zurückzuführen ist, die eine Änderung der Körperform bei Italienern, Böhmen und Juden bewirken. In Anbetracht der bestimmten Angaben über die Behandlung der Kinder *darf man wohl annehmen, dass der wesentliche Grund in dem Wechsel der Behandlung zu suchen ist.*

"Die Beobachtung des Hinterkopfes zeigt, dass viele Individuen eine starke Rundung zeigen, doch findet auch eine beträchtliche Zahl planoccipitaler Individuen, deren Köpfe nicht künstlich abgeplattet sind. Mit anderen Worten: die Behandlung des Kindes verstärkt den planoccipitalen Charakter, der aber auch ohne diese Ursache ziemlich oft in die Erscheinung tritt." (Italics are mine.)

I cannot agree with the second paragraph of Boas' conclusions. I am by no means certain what a "beträchtliche Zahl" of 9 subjects would be. I doubt that all vestige of the old-country custom of cradling was given up by the parents of the subjects; and this, together with minor anomalies, such as sleeping habits of the individual, would complicate the picture, even if the subjects of Boas' observations were many more than he actually managed to measure. I think a great deal more ruling-out would have to be done, before one could so blandly state that planoccipital types were genotypically so. I know that in every single one of the cases of peculiar head form, including the planoccipital, that I have been able to investigate with thoroughness, some obvious and external force has been applied, having been given the opportunity by, e.g., personal sleeping position preferences, illness during infancy, and the like.

Interesting tidbits from many anthropometric studies could be added to this section. One such would be von Luschan's (1891: 41) famous bimodal curve which indicates that one part of Lycia's population is positively long-headed, the other hyperbrachycephalic. He furnishes similar curves (von Luschan, 1911: 238) for Greeks, Turks, and Jews. Another interesting bimodal curve is that of Tschepourkowsky (1911: 159) for Russian women's cephalic index — their stature and facial index

curves being unimodal. It is tempting to interpret these phenomena as results of a differential infant treatment in the populations in question. But there is little use in speculating on evidence for or against our thesis, in cases for which accurate knowledge of the factors and customs involved is lacking.

THE EMBRYOLOGICAL AND OBSTETRICAL LITERATURE

The influence of the fetal brain on the shape of the head is admitted by all. Father C. J. Connolly (personal communication) tells me that the fetal brain is indeed at first globular, but that he cannot agree with Macalister's (1898: 335) statement that the central, parietal, and temporal lobes grow more quickly than the rest of the brain. It is, however, a generally experienced fact that the fetal head is brachycephalic, and often hyperbrachycephalic. Many authors have given this situation their attention. Vilas (1929), desirous of checking on Retzius' (1904) work and seeing whether Retzius or his opponents were correct, found moderate brachycephaly in the fetus from three to nine months, and says (p. 705) that at least for the first six or seven months of fetal life, there is no noticeable racial difference with regard to the cephalic index. However, Vilas was presumably dealing with Viennese subjects (although he does not give racial data). Lecourtois (1869) triumphantly confronts Welcker (1862) and Schaaffhausen (1866), who had pronounced for the brachycephaly of the fetus, with the fact that there could be cases of dolichocephaly among fetuses, because he found some in Paris. In spite of the small number of subjects, those who are accustomed to dealing with arithmetic means are not so surprised at this as Lecourtois was pleased. Schultz (1926) shows that the average of 200 white fetuses of the third and fourth month is hyperbrachycephalic.

If I understand the measurements of Calkins (1922) aright, his rearrangement of the data allows him the conclusion that the fetus is dolichocephalic at the beginning (23–50 C–H L) group, gradually rises to an index just below 80, and then stays there. His groups are made up according to the crown-heel length. He claims (p. 128) that the relationship between any two dimensions of the fetus is according to the formula: $y = ax + b$, where x and y are the bodily dimensions in question, and a and b are constants. He states (p. 129) that a definite rate of growth has been established by the third month, and is maintained during the rest of prenatal growth. His position is that birth molding probably leads to much greater changes in head dimensions than is usually thought the case. Father Connolly (personal communication) is quite definite in stating that there is an occipital lengthening near term or at birth, or both.

This is as good a place as any in which to introduce a short note of theory concerning the growth of the bones of the skull. I have already mentioned some general expressions of opinion concerning the relations of function and form, muscle and bone (Chapter II, in connection with the growth and sculpture of the mandible). Here we are dealing rather with the relations of part to part in the initial and early growth of the bones of the vault of the head. These are membrane bones, usually opposed in standard classifications to the cartilage bones. Mainland (1945: 84) remarks that this classification has overstressed the opposition between the two types of bones, because all ossification occurs in connective tissue; because craniocleido-dysostosis affects many cartilage bones, as well as membrane bones; because the reason membrane bones have poor regenerative powers is probably the early closure of their period of active growth (the head being in advance of the rest of the body in this respect [compare Weinmann and Sicher, 1947: 55]).

But here I am dealing with the mechanical relations between capsule and contents. Thoma (summarized by Weinoldt, 1922: 312–14) believes that any bone has the power of growing in any direction by interstitial addition of parts. In the case of the skull, the contents exert pressure in all directions, but obviously the skull does not grow equally to a perfect sphere. So, in order to explain the tubera, he elaborates his "Druckpolentheorie"; namely,

that the fetal brain must speed up or intensify its pressure on certain points or areas at certain times. The stresses on the fetal vault bones, unlike the stresses on the long bones, are not pressure-stresses but tension-stresses ("Zugspannungen").

Weinoldt (1922) disagrees with Thoma specifically on his "Druckpolen." He points out that the early, purely epithelial fetal "skull" is globular, but that with the onset of ossification at the centers, the adult shaping begins. He also points out that an equal pressure in all directions, which is about all we know of the activity of the fetal brain and its concomitant liquids, does not explain the ossification of the various vault bones. He adduces pathological cases (pp. 316–18), in which at birth the brain is little more than a bladder filled with liquid, but the vault bones of the subjects are moderately normal in structure. This is backed up by numerous examples in Murray (1936). In cases of anencephaly (pp. 319–22) there is no influence of the nonexistent brain on the vault bones, yet these bones are all clearly perceivable, although not normal. Weinoldt emphasizes the important fact that the walls of the cranial case are attached to the base of the skull, and he ties this in with the arching of the vault and the bending of the basis. One is reminded of the striking photographs of Thomson's (1903) experiment with a skull base and a bladder, gradually filling with air; except for the saddening fact that that experiment, dramatic as it was, proved nothing. There is more to racial and developmental differentiation of the skull, as well as idiosyncratic development, than such simple factors. But, Weinoldt continues, the vault bones are not everywhere of the same build: where the falx is attached, there is a strengthening of the bone, due to resistance to tension. So the areas of expansion are between the base of the skull and the attachment of the falx. Here the centers of ossification are found, and they lead to the formation of the sundry tubera. Specifically concerning the occipital, he indicates the influence of the falx and the tentorium, and also the fact that this region suffers the first real tension to come from outside the skull, namely that of the neck musculature. He concludes (after a consideration of suture-closure which does not especially interest us at this point) that the first conditioning of the bones is by hereditary factors; afterwards mechanical forces make themselves felt. This conclusion is much the same as the general remarks about Wolf's Law we presented in Chapter II; and the over-all picture of the mutual interworking of capsule and contents proposed by Gudden (1874) still remains conceptually important, even if both of these two are again broken down into two aspects, the hereditary and the functional. How obscure the final result is, at least to statistical study, is proven by the study of the individual bones undertaken by Pearson and Woo (1935).

Weinmann and Sicher (1947: 43) disagree completely with Thoma, and state that one of the most important advances in our knowledge of bone development is the demonstration that there is no interstitial development of bone; growth of bone occurs only by addition of bone to free bone surfaces, i.e., by appositional growth. We have already noted how compatible this concept is with the findings of Pearson and Woo. Specifically with regard to the growth of the bones of the skull during the early years of the individual's life, Weinmann and Sicher (1947: 87) claim that growth in size of the individual bones is achieved by apposition of bone in the sutural areas, but the necessary flattening (in keeping with the increase in radius of the growing brain) is brought about by resorption of the inner surface of the bone near the sutures plus apposition of bone in the central area of the bone in question. It would be interesting to see a detailed study of the internal structure of the occipital in flattened and unflattened skulls. Glücksmann (1938: 107; 1942: 238) has shown that pressure and tension can produce orientated bone structure in unorientated osteogenic material *in vitro*; one should suspect, therefore, some discernible difference between occipitals that have been subjected to early pressure and those which have not been so influenced.

Vilas (1929: 708–12) found that the intensity of breadth growth of the skull increases for the period included by the third to the fifth fetal month, then quickly decreases to about half of this intensity, and remains constant during the subsequent time of gestation, beginning with the sixth month; the length always gains more than the breadth (with rela-

tion to the cephalic index), but particularly around the time of birth. These findings seem never to have received an explanation by any other investigator. Shilova (cited in Field, 1948: 237–38), studying 725 embryos and fetuses, found a constant rise in cephalic index during uterine life. In 339 cases (56.2 per cent), the newborn infant was brachycephalic (80.0 – 84.9); during the first three months the cephalic index increases, the predominant form being mesocephaly; from the fourth to the tenth month the index varies slightly, but the predominant form is brachycephaly.

The general experience, however, certainly is that the newborn head is not as brachycephalic as the adult head, for the same population. Just when the head achieves this higher index will be pointed out in the next section. Kruse (1934: 1755) tells us that all over brachycephalic Germany, infants brought into the world by a Caesarean section average 81.5 in the cephalic index, but the infants born normally are universally 79. Kugler (1931: 431) studied 250 male and 250 female newborn infants in Zürich, and finds their average cephalic index to be respectively 77.0 and 77.9, although, of course, the ranges were enormous (69.1 – 87.5; 67.5 – 91.8). Freeman and Platt (1932: 71) give the head lengths and breadths of various racial groups, for which I calculate the following cephalic index values for the males: Americans, 81.7; Germans, 78.5; Poles, 80.2; Jews, 81.3; Swiss, 75.9; more Americans, 79.8. Bakwin and Bakwin (1934: 613–14) supply measurements for American infants, first-born and later-born, from which the cephalic index of 79.1 and 79.2, respectively, emerge. Abbie (1947: 250) sets the neonatal cephalic index in the lower 80's, but in general it should be slightly lower. His own 39 European infants average 78.4, and Ranke's 20 (mean of 81.5) range from one to twenty-one days in age, thus ignoring a precaution in measuring newborn infants' heads which will be discussed below. More examples may be found in Krogman (1941b); and Davenport (1940) will be cited in another connection subsequently. We can, therefore, agree in a very general way with Neuert (1937: 145) when he says that the newborn children of even predominantly brachycephalic and hyperbrachycephalic parents definitely tend towards dolicho- and mesocephaly. This is an important point in our understanding of the history of head form.

The suspicion has no doubt been created, that this sudden trend towards dolichocephaly is caused by the influences exerted on the young head during the process of birth. This problem has been studied by obstetricians, and their general opinion, so far as I have been able to discover, is that deformations of the infant's head occasioned by normal birth experiences are transitory in nature.

Vogel (1924), for instance, made a study of newborn infants who had had normal births. He measured these subjects as soon after birth as possible (the latest was ten hours in the world), and then again on the eighth day after birth. He concludes that the head of the newborn infant is not elastic, but plastic. It keeps whatever change in shape has been forced on it by the process of birth, but gradually loses most observable deformations by the eighth day. His warning, that there is in almost every birth some deformation of the head, makes one wish one had more accurate knowledge of just when some investigators had measured their subjects. Vogel points out, as did Budin (1876a) very clearly and long before him, that in some births the bones of the skull can be forced to overlap each other. Only in the worst cases does one parietal bone slide over the other, while in the lightest cases of deformation, the parietalia (one or both) can overlap the occipital. Premature babies seem to experience the more serious deformations. These are caused, primarily, according to Vogel (p. 159), by the soft parts involved in the process of birth, because all these deformations can and do occur in cases where the mother's bony pelvis is perfectly normal. But the bony pelvis may play a further part in deformation, as is especially the case with abnormal births (p. 167).

Backer (1891) noted the influence of the different states of fontanelles, sutures, and rigidity of bones of the skull on the newborn's head, and also claimed to have noted a narrowing of the head of the infant if the mother's pelvis had been narrow. Müller (1907, and many other papers in the *Archiv. f. Gyn.*) arrived at the opinion that the general shape of the skull was hereditarily conditioned, but that the dimensions and shape of the skull

could be varied within narrow limits. Stumpf (1907) also mentions the ministrations of the obstetrician as a factor in head deformation. Müller (1907) and Kehrer and Lahm (1920) and Wehefritz (1928) and Stratz (1921) all agree that the process of birth usually leaves only transitory deforming effects on the infant skull. Henkel (1934) gives photographs of some startlingly deformed newborn heads, and also those which show how these deformations are lost within two to four days after birth. This has been the experience of many fathers and mothers — to their great relief. Neuert (1933: 240) investigated the relations of various head forms to the position of the fetus in the uterus and the type of presentation at birth, but I do not judge these conclusions to be of particular importance to our problem. I think, however, it is of moment that absolutely none of these authors speak of any form of flattening of the head as entering into the picture of birth deformations. Davenport (1940: 69–70) reports on the unpublished dissertation of Tiber (1930), who investigated the influence of "birth-molding," and concludes that the sagittal-oblique (sub-occiput to bregma) is perhaps the dimension which is most changed (in this case reduced) by the muscles of the walls of the birth canal, in cases of normal vertex presentation. Scammon and Calkins (1929: 98) state the reduction to be on the average 9 millimeters, but this amount is restored during the first ten days of postnatal life. The fact that the average cephalic index of infants is reduced somewhat during the first two or three days of that life (Kugler, 1931: 564) indicates that the head breadth is slightly and temporarily increased by the birth-process.

On the whole, until some new evidence forces us to another conclusion, we cannot assume freely that any radical changes towards dolichocephaly are caused by the normal processes of birth — rather, the burden of evidence is in favor of the opposite conclusion.

THE LITERATURE FROM PEDIATRICS, AND GROWTH STUDIES

The most interesting and pertinent phenomenon of postnatal growth from the point of view of our present study is the fluctuation of the cephalic index during the first year of life. Infants are mesocephalic, for the most part, at birth. The brachycephalic groups of the world arrive at adulthood with this index changed to a much higher one. Most growth studies, taking the children from five, or ten, or even two years of age on to adult life, emphasize the fact that the cephalic index varies little during the period subsequent to the first year of life. Both Davenport's study (1940) and the data of Bayley (1936) show what happens during the critical period of postnatal life with respect to the cephalic index. What happens is very intriguing (fig. 8).

The infants (in this case, Americans), starting at birth with an index somewhere between 76 and 79, experience a *very rapid increase* in cephalic index until at the age of eight or nine months they have become hyperbrachycephalic. Tschepourkowsky (1911) noted the same trend in Russian babies during the first six months of their postnatal life. Then the cephalic index takes a fairly sharp bend downward to low brachycephaly, where it evens off at about 81.

This a very peculiar pattern, and it is all the more peculiar when we consider the concomitant growth curves. The human growth curve, for absolute measurements and weights, is uniformly the same, no matter what characteristic is observed. As Weinbach (1941: 219) says: "From birth to puberty the course of growth in body weight, although made up of a decelerating and an accelerating portion, shows no discontinuity, and there is no physiological evidence of any modifying influence on the course of growth." At puberty, there is obvious manifestation of the internal disturbances caused by the endocrine glands. There is no evidence of any such disturbance when we regard any characteristic of the growth curves of the first year of life.

The curves for the growth of head length (Davenport, 1940: 7), and for head breadth (p. 17), are of the same nature. Yet Davenport (p. 8) well says of head length: "Hardly another dimension of the body is so precocious in its development as to be three-quarters finished at 6 months post partum." And of

head breadth (p. 18): "Thus the amount of growth of head width is at first about the same as that of head length, but *after 2 years* slows up greatly." (Italics are mine)

If we turn to the growth curve of the human brain for this period, as exhibited in brain weight, we find (Scammon, 1936: 150) the whole brain growth in weight from zero to twelve months an absolutely straight line; and the same is true of parts of the brain, the cerebrum (p. 152), the cerebellum (p. 154), and even the brain stem (p. 155). In addition to the regularity of growth in weight, Brodie (1941) has shown that the growth of the young skull is completely concentric and regular.

is usually laid on its back. Only at five months does the normal infant roll over into another position, without being assisted in the act (Aldrich and Norval, 1946: 305). It is interesting to note that the normal, average American baby begins to walk with help at 9.5 months (p. 306) — and it is at this newly active period that the cephalic index begins to be lowered. At twelve months, according to Aldrich (p. 307, although she admits that all other authors put this date somewhat later), the average infant walks alone, at least for a few steps. At any rate, this period of the first year of the life of an infant, i.e., from nine to twelve months, is obviously a time for intense and

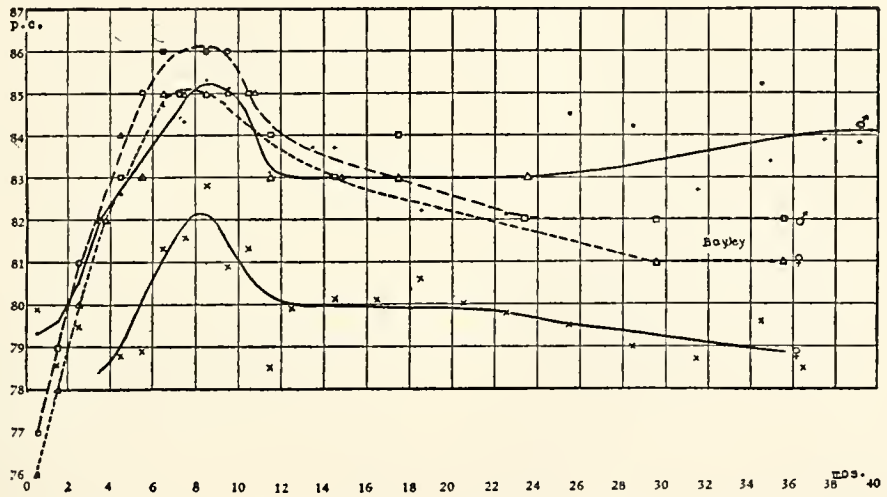


Fig. 8. Mass curves of change with age of cephalic index, babies only, male and female. Unbroken lines, Babies Hospital, males above, females below. Broken lines, from data of Bayley, 1936. Abscissae in months. (From Davenport, 1940, fig. 49, p. 63.) Courtesy of the American Philosophical Society.

There is evidence here of no disturbance in the regularity of growth, but there is a disturbance in the cephalic index. A change from 77 to 86 to 81 is quite a variation up and down the scale. I submit that, until some evidence of internal nature can be adduced, the possibility of this disturbance of the cephalic index being caused by mechanical and external factors is very high indeed.

Now, unfortunately, I have no data on the way these infants studied by Davenport and Bayley lay in their cribs. But the average baby, unless deliberately turned, or placed on its stomach, lies in the position he is put in, and

mobile activity on the part of the child. It is the period when it begins to crawl and then walk. It is interesting to note that Walcher (1905a), too, found difficulty in keeping his experimental babies in a predetermined position while sleeping, from the ninth month of their life.

Bayley (1936: 8–13) is inclined to regard external mechanical forces as very important in the molding of the head form of the infant. In view of the dramatic results obtained by the Maronites in cradling, we should not be vastly surprised if less drastic methods of incomplete immobilization should produce some, even if

much slighter, effects. Bayley attempted, specifically for our problem, to rate her infants on a seven-point scale of activity at twelve months, and to correlate these observations with the cephalic index. On that basis, one could expect only a most crude correlation. The coefficient she got was –.39, and she concludes that "pressure on the back of the head does have some influence in changing a child's cephalic index" (Bayley, 1936: 11). But Davenport (1940: 73) does not seem impressed with the efficacy of Bayley's technique in this case. He himself (p. 74) compares the head height with breadth, length, and cephalic index for four boys and four girls "known or believed to have been bed-ridden," with normal averages. These eight subjects were measured at ages from twenty to twenty-seven. Davenport gets results which show only a little difference between bed-ridden and normal subjects, by averages. However, not only are his numbers small, but I find among his bed-ridden subjects such eccentric indices as 84, 87, 94, 95 — a large number for any normal American population; *and*, neither Davenport nor I know anything about the position normally assumed by these people in bed. We need a great deal more information on this subject, and I am sure it is a fruitful little field for investigation.

Davenport (1940: 23–31) also studies the head height (as he does a whole row of measurements and indices): his infants exhibit a small sharp deceleration of the growth curve (p. 25) at about one year of age, and a dip in head height between three and five years of age. He attributes the first deceleration to gravity. This does not completely satisfy me. There might well be a factor of compensation here. His treatment of the relations of head height and head length (pp. 76–83) does not illuminate the situation for me. Davenport studies other parts of the head and face, and presents a thoroughly excellent and important paper; these other considerations are not, however, pertinent to our study.

His work on the pre- and post-auricular lengths of the head, however, is of value here (pp. 47–53). The growth-curve of the post-auricular length shows the same general shape as all other growth curves (except that of the cephalic index) in infants, with a noticeable dip, however, at around eight to nine years of age. The particular time that interests us is thus described (p. 47): "During less than 6 months to birth the post-auricular part of the cranium increases 40 mm. or at the rate of about 75 mm. p. a. During the first post-natal year the average increase is, in the male, from 59 to 81.7 mm., or at the rate of 22 mm. p.a. This year is characterized by a marked bulging of the occipital bone." Here again, we have an apparently natural process which does not in any way explain the changes in the cephalic index we have noted.

The curve comparing the post-auricular length to total head length is a peculiar one (Davenport, 1940: 95), with a tremendous trough following a maximum reached at birth; the line then rises from two to three years, and almost comes back to the level of the birth-maximum at three to four years. Some of this eccentricity is caused by the migrations of porion, already noted by Neumayer (1908; compare Martin, 1928: 707); and these migrations also condition head height, because the migration is downward as well as towards the rear (p. 53).

Davenport's (p. 75) final conclusions with regard to the cephalic index are: "The causes of the great increase in brachycephaly during the first post-natal year are uncertain. There is some reason for thinking that the habit of sleeping on the back of the head may cause it in some cases. The most probable cause in the latter half of the first post-natal year is an increase in width dependent on the flattening of the brain and brain case that accompanies the acquisition of vertical posture." However, a glance at his curves will show that the latter half of the first year but continues the process begun during the first half, until the picture radically changes after nine months.

That the head then, after the first year, settles down to a shape that will be but slightly changed until adulthood, is shown by the results of a myriad of investigators. The changes that are exhibited by some groups are considerably larger than those of others. Much detailed work, not merely of measurement of wholesale and indiscriminate groups of children, but of painstaking correlations with all sorts of factors (for instance, sleeping habits), will have to be done before the pattern

of the cephalic index change with growth will begin to mean much, in causal terms.

Information concerning the fusion of the various bones of the skull does not seem to throw much immediate light on the process of growth of the head, or on the relations of growth to the cephalic index. The various parts of the occipital bone fuse between the second and the fourth year of life (Hasselwander, 1931: 474), but the squama of the occipital is already a unified bone at birth (except for specimens having wormian bones — Martin, 1928: 838). In place of the future suture there are septa of fibrous tissue contiuous with the pericranium externally and with the dura internally. As yet the bones of the skull are not differentiated into the two tables separated by diploë of later life (Pancoast, *et al.*, 1940: 59). The occipital fontanelle exists at birth (it closes late in the first year of postnatal life), but it is not very large. I have no information on the plasticity of the newborn bone or on the tensile strength of the fibrous tissue. By the fourth year the head is much what it will be in adult life, with the exception of effects produced by a later small relative growth in length.

Hellman (1932: 790) arranges children in a series based on stages of tooth eruption. His subjects showed an average cephalic index of about 78.7 at an average age of 5.53 years, and one of 77.8 at 20.83 years.

I shall now very briefly list a number of studies on the cephalic index according to age differential, among males of various peoples. Working on 100 *French* boys, Godin (1935: 184) obtained a cephalic index of 82.21 at thirteen and one-half years, and one of 79.2 at twenty-three years. Ranke (1905: 174) found the following indices for various ages among the 2509 *German* male children he studied: birth to twenty-one days, 81.5; one year, 83.9; two years, 82.5; three years, 84.8; fifteen years, 81.8. Kretschmar (1932) compares *German* and *Swiss* thus: at ten, 83.6 and 84.3; at nineteen, 82.4 and 83.0. Schwerz (1911) found a difference for *Swiss* (Schaaffhausen) of 0.9 points, between a cephalic index of 83.2 at six, and 82.3 at twenty.

The studies on *Americans* have been numerous. Freeman and Platt (1933: 196–204) give the cephalic index by months and years to eight, and by years thence to fifteen. Their figures commence with a cephalic index of 82.83 at the second month, and at the end of fifteen years it is 81.83. Gray and Ayres (1931: 72–108), studying Chicago private school boys, have 83.0 at the first year (more accurately put, at 0.5 to 1.5 years), 81.0 at the fourth year, 79.3 at the fifth year, 78.9 at the seventh year, 77.9 at the nineteenth year. Lucas and Pryor (1935: 540–43) indicate that California boys under one year have a cephalic index of 82.6; at one, 80.6; at two, 78.9; and at fifteen, 80.0. The Iowa Child Welfare Research Station (1929) figures follow the same pattern for their children from three to six years. So does the series of Meredith (1935: 23–24), who gives head lengths and breadths for Iowa City boys. Bayley (1936: 10) presents an interesting comparison of first-born and non-first-born: the first-born at one month have a cephalic index of 77, and of 82 at thirty-six months; the non-first-born, 77 at one month, and 81 at thirty-six months. Not much difference between the two groups is indicated.

For the *English*, we may cite Myers (1926: 92–93) on London children, as follows: at six months, 81.3; at twelve to fifteen months, 78.7; at twenty-one to twenty-four months, 78.5; at thirteen to fourteen years, 78.0. This differs considerably from the results found by Pearson and Tippett (1924: 120), who discovered no difference for English male children, comparing those of an age of 4.5 years and those of 20.5 years; although they did discern (p. 125) a slight difference for females. It is likely that sampling has a great deal to do with discrepancies like these.

Morros Sardá (1934), it is true, reports an amazingly homogeneous series for *Spanish* children: at six years, 77.8; at fourteen, 77.0. The pattern that Appleton (1927: 250–51) depicts for the *Chinese*, on the other hand, is a puzzling one. She has three series, one of Chinese boys in Hawaii, one in East China, and one in Kiangsu. All three series show a break in the direction of reduction of the cephalic index. The first two have a break of practically three points at eleven to twelve years and eight to nine years, respectively; the third shows a similar change at nine to ten years, a change of two points.

The general pattern, however, is repeated in Hirsch's (1927: 83) comparison of Boas' foreign-born and American-born *Jews*, and his own series of American-born Jews. Herskovits (1927: 305) finds among the *American Negroes* a cephalic index of 81.17 at the age of one, 79.33 at two, and his adults (N=961) have a cephalic index of 77.09.

Finally, Keiter (1933: 346) and Wissler (1930: 126–27) give synoptic tables for various groups, and the general pattern holds throughout. Still more tables are contained in Krogman (1941b).

The picture, then, is fairly clear. The human head goes through a disturbed period in the first year of life, but soon settles down to a cephalic index which differs but little from the adult index. And if we had some method of measuring a cephalic index without including the supra-orbital ridges of the male, it would in all probability be even more stable. At all events, *except for that first year*, the cephalic index behaves in a very sober and orderly way. During the first year, it reverses itself in an unusual manner. I suggest that a large factor in this procedure is infant bedding.

I wish also to emphasize that, subsequently, the cephalic index is normally reduced very little or at most two points, and that it is normally somewhat greater than that of the newborn. Hence, it would seem that the cephalic index is quite generally affected by external forces. I suggest that an accurate assessment of such forces must be made for individual populations before it can be said that our knowledge of the normal adult cephalic index and its causal relationships is complete.

MEDICAL LITERATURE

In considering the medical literature I have omitted delving into the obviously teratological; I have not contemplated such phenomena as the turricephaly (Pancoast, *et al.*, 1940: 81–82), and the like, since these are easily recognized. There is no reason to believe that the whole Lebanese Maronite series was composed of pathological cases that no one could avoid diagnosing. The syndromes of such moderately rare and very easily diagnosable diseases as include planoccipitaly or hyperbrachycephaly are of such a nature that, even if the patients managed to live until adulthood, no anthropometrist would select them as normal subjects for a series. Examples of such diseases are: acrocephalosyndactyly (Buckley and Yakovlev, 1948), cranio-facial dysostosis (Crouzon, 1935), and Mongolism (Ingalls, 1947).

There are several diseases, however, which have a direct positive connection with the problem we have been studying. One of these might well be rickets, or craniotabes in the case of the skull. Münch (1935) has investigated this very point among German children. The diagnostic signs of craniotabes are: a thickening of the suture regions, and especially a thickening of the tubera frontalia and parietalia, and, in general, the *Caput quadratum* (see also Pancoast, *et al.*, 1940: 186). There are also diagnostic signs of rickets in the other parts of the body, of course, so that even without a clear-cut picture being obtained from the head, one may tell whether the child in question is rachitic. Münch shows that non-rachitic children had a lower cephalic index than those afflicted with the disease. But the cranial diagnostics themselves, according to her, have only a very small effect on the cephalic index.

Ylppö (1919) studied the course of craniotabes in premature babies. For them, he concludes, the period of this disease lies within that from two to twelve months of age, and it definitely conduces to occipital flattening. Peiper (1923) uses flattening as one of his diagnostic criteria in judging whether or not the patient had had rickets at an early age.

It seems certain that early rickets (plus the normal pressure of the infant's head on the pillow) can assist materially in the production of occipital flattening (Weinmann and Sicher, 1947: 263). Hence, this factor would have to be taken into account, when diagnosing a population with respect to the cephalic index. In the case of my Lebanese series I can state with considerable affirmation that there is no indication of early rickets. Nor was there any

in the 254 Maronite skulls I studied while in the Lebanon, except for two very doubtful cases, in which the characteristics could well have been produced by a different disease and probably were. With regard to the 40 skulls scrutinized by Melconian and Schaepelynck (1947), these authors (who are medical men) specifically rule out oxycephaly, acrocephaly, plagiocephaly, and syphilis, and mention no other pathological manifestation: Incidentally, they reject the possibility that early cradling may have caused the occipital flattening noted in 17 of their skulls; they hope later to be able to study the brains from such skulls, and expect to find in some disease the cause of the deformation. I am permitted to doubt, at this late stage in our discussion, that it will be along this path that they will come on the true cause of occipital flattening.

Finkbeiner (1923: 59–60) shows from data collected by Scholz (1906) that cretins in Germany are very brachycephalic, the average cephalic index for males being 86.5. Quite probably he is correct in thinking that cretins have a higher cephalic index than has the surrounding population; but he does not analyze the racial factor in his material.

That there might be a connection between thyroid disturbances or deficiencies and brachycephaly is indicated by Lang (1928: 48), who concludes from his investigations in Munich that the hyperbrachycephals show a definitely higher incidence of goiter than do the dolichocephals. Weidenreich (1925: 41) refers to the data of Müller (1925: 1) on the very brachycephalic Tirolese, among whom 46.7 per cent of the male children and 54.0 per cent of the female children suffer from goiter. Similar results were obtained specifically in the Volksschule of Innsbruck. All I can say at the moment is that goiter is not a common disease in the Lebanon. In fact, I can recall having observed only one case of this disease, during my three-years' experience in the country.

This whole question of the relation of difficiencies and diseases to head form needs more extensive investigation.

CONCLUSIONS FROM THIS CHAPTER

The facts of artificial cranial deformation show that the head of the newborn infant is quite plastic, and may be formed one way or the other, to a greater or lesser degree depending on the intensity and duration of the application of force from without; this artificial form may persist into adult life.

Craniological studies indicate that the difference between brachycephaly and dolichocephaly is chiefly in the posterior portion of the skull. This is not inconsistent with the possibility that external pressure is a large factor in the shortening of even other types of heads than the hyperbrachycephalic; and certainly it does not militate against the generalization from the experiment made in Chapter III.

Studies on the problem of brachycephalization leave room for the factor of external mechanical force applied at an early age. Other explanations have not entirely satisfied students of this problem. There are certainly at least some instances in which such forces played a large part in conditioning head form. Various experimental studies seem to indicate that such forces can produce an effect on a percentage of infants' heads.

General anthropological literature is not of great use in studying this problem, since it is nonexperimental. Such experimental anthropometry as has been done corroborates our thesis.

Embryological and obstetrical literature indicates that, although the fetal head is more or less brachycephalic, the newborn infant is generally mesocephalic. This lengthening of the head about the time of birth is not normally due to factors involved in the process of birth.

Pediatrical and growth literature teaches us two important patterns in the early life of the cephalic index: it is extraordinarly affected by some disturbance, which may well be largely the factor of external mechanical forces, during the first year of life; and the head form at the end of the first year is that of the adult, except for a general relative lengthening of the head which reduces the cephalic index by an amount up to two points, rarely much more. Thus, the early form of the head per-

sists, with moderately small changes, which are predictable.

Medical literature proves that various diseases: rickets, and goiter notably, can disturb the cephalic index. Experimental work on animals has already shown that deficiencies and overdoses of vitamins can affect the head form of these animals. These factors invite future work.

SUMMARY OF CONCLUSIONS FROM THIS STUDY

FROM the comparison of the observations and measurements on the two series, Lebanese and American, of Maronites, I conclude with certainty that in the case of this group the flattening of the posterior portion of the head (no matter what particular form it may take) is caused by the Lebanese custom of cradling the infant. The hyperbrachycephaly of the Lebanese series is due to the same cause.

The interference with natural form occasioned by the cradling custom affects primarily the posterior portion of the brain case.

It would seem that the face is not affected by this process of deformation.

A study of the world-wide distribution of hyperbrachycephaly, and of that of methods of producing changes in the shape of the head (cradling, or the equivalent), gives the general picture of a correlation between the two distributions. This correlation, in view of my experimental results on the Maronites, gives extremely strong probability that the two phenomena are causally related in large areas for which there is good information; there is strong probability that the causal connection is quite general; but it is certain that in every area the factor of infant postnatal treatment must be accurately assessed in making judgments on the cephalic index, or in making use of this index in racial or other physical diagnoses or conclusions. This is true not only when the index is hyperbrachycephalic; since the effects of infant treatment can be small as well as large, depending on circumstances.

These conclusions are strengthened by those reached in other studies. The literature on artificial cranial deformation shows clearly that an unnatural head form imposed on an infant can remain such into adult life. Craniological studies emphasize the difference in the posterior portion of the head when dolichocephalics and brachycephalics are compared. In general, they indicate the greater value of the face as over the brain case for diagnostic criteria. Studies on the problem of brachycephalization suggest the need for the interpolation of the factor of infant treatment into explanations hitherto erected solely within the framework of racial concepts. Prenatal and postnatal studies show that the average uncradled infant is born mesocephalic, but becomes first hyperbrachycephalic during a period when nondrastic infant treatment is most apt to have its effect, and then brachy or meso later on. The head form achieved at the end of the first year of life is retained into adult life, with a lowering of the cephalic index by at most two points. Therefore disturbances in the cephalic index do not have to be as dramatic as those among our infant Lebanese Maronites in order to affect the adult index.

The most general — and monitory — conclusion of this study is that the cultural factor influencing early (and therefore later) head form must be reckoned with in physical studies. After all, no matter how denatured by statistics and geometry, it is still the *human* head we are studying.

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Reports of the Peabody Museum's activities have been published annually since the year 1868. From that date through 1890, 24 Annual Reports were printed, embodying not only the routine accounts and summaries but also the expedition and research reports of the type which since that time has been incorporated in the Papers and Memoirs. The 8th, 11th, and 15th are now out of print. The others are available at 75 cents each with the exception of the following:

Tenth Report, containing the following articles:
Discovery of supposed Palaeolithic Implements from Glacial Drift in Delaware Valley, near Trenton, New Jersey, by C. C. Abbott. (Illustrated); Age of Delaware Gravel Bed Containing Chipped Pebbles, by N. S. Shaler; Exploration of Ash Cave in Benton Township, Hocking County, Ohio, by E. B. Andrews; Exploration of Mounds in Southeastern Ohio, by E. B. Andrews. (Illustrated); Exploration of Mound in Lee County, Virginia, by Lucien Carr. (Illustrated); Art of War and Mode of Warfare of the Ancient Mexicans, by A. F. Bandelier. $2.00.

Twelfth and Thirteenth Reports (under one cover), containing the following articles:
Measurements of Crania from California, by Lucien Carr; Flint Chips, by C. C. Abbott. (Illustrated); Method of Manufacturing Pottery and Baskets among Indians of Southern California, by Paul Schumacher; Aboriginal Soapstone Quarries in District of Columbia, by Elmer R. Reynolds; Ruins of Stone Pueblo on Animas River, New Mexico, by Lewis H. Morgan. (Illustrated); Social Organization and Mode of Government of the Ancient Mexicans, by A. F. Bandelier. $2.00.

Sixteenth and Seventeenth Reports (under one cover), containing the following articles:
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Eighteenth and Nineteenth Reports (under one cover), containing the following articles:
Notes on the Anomalies, Injuries, and Diseases of Bones of the Native Races of North America, by William F. Whitney; Marriott Mound and its Contents, by F. W. Putnam. (Illustrated.) $2.00.

The 25th and following brief Reports are printed in the Annual Reports of the President of Harvard University. Reprints of all but the 25th, 26th and 27th may be obtained by applying to the Peabody Museum. Price, 35 cents each.

(Continued from last page)

SPECIAL PUBLICATIONS OF THE PEABODY MUSEUM

NOT AVAILABLE FOR EXCHANGE

The following works on American archaeology and ethnology, not originally published by the Peabody Museum, are for sale. Some of them relate to certain collections in the Museum.

A Journal of American Ethnology and Archaeology. Containing Papers of the Hemenway Southwestern Archaeological Expedition. The Mary Hemenway Collection is exhibited in the Museum. Square octavo. Maps and illustrations. (Discontinued after Vol. V.)

VOLUME I. 1. A Few Summer Ceremonials at Zuñi Pueblo. By J. Walter Fewkes. 2. Zuñi Melodies. By Benjamin Ives Gilman. 3. Reconnaissance of Ruins in or near the Zuñi Reservation. By J. Walter Fewkes. $2.00.

VOLUME II. 1. A Few Summer Ceremonials at the Tusayan Pueblos. By J. Walter Fewkes. 2. Natal Ceremonies of the Hopi Indians. By J. G. Owens. 3. A Report on the Present Condition of a Ruin in Arizona called Casa Grande. By J. Walter Fewkes. Out of print.

VOLUME III. 1. An Outline of the Documentary History of the Zuñi Tribe. By A. F. Bandelier. 2. Somatological Observations on Indians of the Southwest. By H. F. C. Ten Kate. $2.25.

(No. 1. of this volume may be obtained separately. $1.75.)

VOLUME IV. The Snake Ceremonials at Walpi. By J. Walter Fewkes, assisted by A. M. Stephen and J. G. Owens. $2.00.

VOLUME V. 1. Hopi Songs. By Benjamin Ives Gilman. 2. The Hemenway Southwestern Expedition. By Benjamin Ives Gilman and Katherine H. Stone. Out of print.

(Concluding volume of the Journal, published November, 1908.)

Human Bones in Hemenway Collection (Southwestern Archaeological Expedition). Described by D. Washington Matthews.

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(Reprint from Vol. VI, Memoirs of the National Academy of Science.)

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Ydioma Zapoteco del Valle. Contains some common rules of grammar, a copious vocabulary, a confessionary, and other things which the Christian reader may see. 2 vols., 1793; Vol. I, 286 pages; Vol. II, 292 pages. Vol. I, $33.00; Vol. II, $33.00. (Original in the John Carter Brown Library, Providence, R. I.)

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